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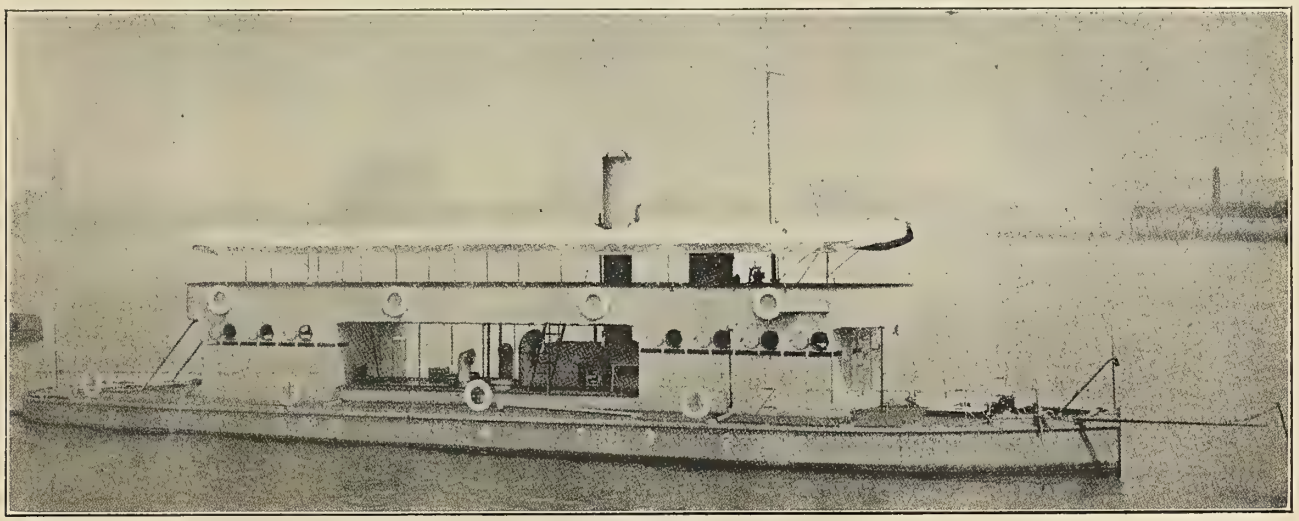
SHALLOW DRAFT GUN BOAT.

Yarrow's system of propulsion for shallow draft boats, consisting of twin screws, working in tunnels fitted with patent hinged flaps, by means of which the maximum efficiency of propulsion is obtained under all conditions of load, has been adopted in the construction of a new gunboat for Macao, a province in one of the Portuguese colonies in China. As the vessel is to be used for revenue service, it must be able to steam in the shallowest waters which are found in that district. The vessel was built by Messrs. Yarrow & Company, of Scotstoun, Glasgow, of the following dimensions: Length, 120 feet; beam, 20 feet; depth, 4 feet 9 inches; speed, at a draft of 25 inches with a load of 25 tons, 12½ statute miles per hour.



PHOTOGRAPH AND SECTION OF YARROW GUNBOAT FOR MACAO.

The hull is divided into 9 compartments by 8 watertight bulkheads. The forward compartment is used as a chain locker; the second and third compartments as provision and store rooms; the fourth compartment as a magazine room for the forward gun; the fifth compartment as the boiler room; the sixth as the engine room; the seventh as a magazine for the after gun, and the eighth and ninth as store rooms. The officers' quarters are forward on the main deck and the petty officers' quarters are on the same deck aft. The machinery space and the officers' quarters are protected by bullet-proof steel plates, while around the battery deck, which is also the berth deck for the crew, there is bullet-proof protection. The sectional view and photograph, shown herewith, give a good idea of the arrangement of the boat. It will be noted that the battery deck is covered by a double awning and that sprinklers are installed above this. As the climate in which this boat is to operate is very hot, this system of cooling the

vessel has been adopted, as it has been shown by experience to be very effective.

Propulsion is by two triple-expansion, surface-condensing engines, operating twin screws placed in tunnels. Two rudders are fitted aft, one exactly in the center of each tunnel. Thus the rudders receive the full effect of the stream of water driven aft by the propellers and give the greatest maneuvering power. The maneuvering properties of the boat are further enhanced by the use of the Yarrow bow rudder. This rudder is so designed that the hand tiller can be unshipped when going ahead and the rudder turned around against the bow of the ship, so as to be completely out of the water. When it is desired to go astern, the rudder can quickly be dropped into the water and its full effect obtained for maneuvering the boat.

Steam is supplied by a Yarrow watertube boiler, working under forced draft on the closed stoke-hold system. The boiler is designed for either wood or coal fuel, and if desired the boiler can be operated under natural draft. Independent main and auxiliary feed pumps are supplied, and a feed water filter is installed to prevent grease getting into the boiler. Besides the usual auxiliary machinery, there is a steam capstan forward for working the anchor and both steam and hand steering gear are fitted.

The vessel is armed with two 2¼-inch semi-automatic Hotchkiss guns and four ¼-inch rifle bore automatic guns, so arranged that three can be fired simultaneously on one side. The vessel is lighted throughout by electricity and carries a searchlight on top of the conning tower.

After the vessel was delivered, speed trials were carried out over a measured course in Kowloon Bay, Hong-Kong, where a speed of 13.156 miles per hour was obtained under contract conditions.

The estimates for the United States naval appropriations during the next fiscal year will probably amount to $128,300,000 (£25,400,000).

NEW ZEALAND RIVER STEAMER.

An interesting type of shallow-draft passenger boat has been built by Messrs. Simpson, Strickland & Company, Ltd., Dartmouth. The hull is 91 feet long, 14 feet beam and 3 feet 6 inches deep, built of ⅛-inch plating on 1½ by 1½ by ⅛-inch frames 15 inches apart. Destined for shallow river work in New Zealand, the draft of water when fully loaded with cargo and passengers was only 13 inches, and, furthermore, the vessel has to pass through some rapids, and a speed of 14 miles per hour was necessary. She was built in sections, which were bolted together at Dartmouth to enable the boat to be tried. The trials being entirely satisfactory the sections were unbolted and sent to New Zealand for final erection.

(Photograph copyrighted by the New Zealand Government, Tourists' Dep't.)

STEAMER OHMA GOING UP THE NYAPORO RAPIDS, NEW ZEALAND.

In spite of the very high speed obtained on the trial of the boat, at certain periods of the year, the rapids have a speed in excess of the boat, and it was therefore arranged to have a strong steam winch on the forward deck with warping rollers over the bows, so that by means of a rope the boat could be warped over the rapids, the engines meanwhile going full speed. It is a very interesting sight to see this maneuver, and by permission of the New Zealand Government we are enabled to reproduce a photograph showing this boat passing through the Nyaporo Rapids; the exhaust from the winch being very conspicuous, and the appearance of the smoke issuing from the funnel is a good indication of what is being done in the boiler room.

The boat not only has ample room for cargo, but is fitted with cabin accommodation for passengers and has a large promenade deck covered by an awning.

The machinery is arranged amidships and consists of two sets of triple expansion engines with cylinders 6 inches, 9¼ inches and 14 inches in diameter by 7 inches stroke, the boiler being of the watertube type. The engines are capable of developing easily and continuously 250 indicated horsepower collectively.

NOTES ON AMERICAN RIVER STEAMBOAT PRACTICE.

BY CAPTAIN T. M. REES.

Naval architects and marine engineers who are not thoroughly familiar with American river steamboat practice frequently are at a loss to know where to obtain accurate information regarding the size of steamboats, tow boats and barges commonly used for transportation on the Western rivers of the United States, and equally obscure are many of the details regarding the manner of building and handling these boats. The design of American river steamers is based largely upon experience, and the following notes are the result of many years' experience in designing and building this type of craft.

First as to the size of steamboats and tow boats and barges used in transportation on the Ohio and Mississippi Rivers; light-draft, steel-hull steamboats, 120 feet long, 24 feet 6 inches beam and 3 feet 6 inches depth, with cabin accommodations, with two engines, 10 inches diameter, 4 feet 6 inches stroke, will carry 60 tons of freight and 5 tons of fuel on a draft of 3 feet of water forward and 2 feet 6 inches aft, at a speed of 12 miles per hour, with a steam pressure of 170 pounds per square inch. A boat 125 feet long, 26 feet beam and 4 feet 6 inches depth of hold, with engines 12 inches diameter, 5 feet stroke, will carry 150 tons of freight on a draft of 4 feet at the bow and 3 feet 6 inches at the stern, the speed being from 12 to 13 miles per hour. A boat 145 feet long, 33 feet beam and 4 feet 6 inches depth, with engines 15 inches diameter, 6 feet stroke, will carry 300 tons on a draft of 5 feet forward and 3 feet 9 inches aft, the speed in this case being approximately that of the foregoing boats. A boat 170 feet long, 33 feet beam and 4 feet 6 inches depth, with engines 15 inches diameter, 6 feet stroke, traveling at a speed of from 13 to 15 miles per hour, will carry 90 tons of freight, drawing 27 inches of water on an even keel. Fully loaded, it will carry from 450 tons to 500 tons. The draft given in the foregoing cases was with stores and passengers aboard, and the speed is from records given by the owners.

Boats of this type are built as large as 275 feet long, 50 feet beam and 8 feet depth of hold. The steamer *Paragon*, which was 265 feet long, 48 feet beam and 7 feet depth of hold, with engines 22½ inches diameter, 8 feet 6 inches stroke, has brought up the Mississippi River from New Orleans to Cairo 1,000 tons of freight on a draft of 5 feet 3 inches forward and 4 feet 9 inches aft, averaging 10 miles per hour against the Mississippi River current. The fuel consumption for twenty-four hours was 1,200 bushels of coal up-stream and 800 bushels down-stream. The total capacity of the boat was 900 tons.

The engines on the boats which have been mentioned are of the high-pressure lever poppet valve type, with adjustable cut-off.

The freight rate from Pittsburg to Cincinnati, a distance of 466½ miles, is 8 cents per hundred pounds on heavy freight, and light freight according to bulk up to 15 cents per hundred pounds. The rate to New Orleans, a distance of 2,200 miles, is 35 cents per hundred pounds up to 50 cents on light freight.

In connection with the figures for fuel consumption, it should be stated that the coal is not the first quality, being run-of-mine and slack coal. On tow boats, on long trips, the boats carry what fuel they can, and then have a fuel flat or two in tow, which are dropped off at different landings, where they are picked up on the return trip. The passenger and freight boats, on the other hand, carry sufficient coal to make the run between the different coaling points on the river where coal is stored and sold.

THE WILL H. ISOM, ONE OF THE LARGEST YUKON TOW BOATS.

TOWING COAL AND FREIGHT IN BARGES.

The following data regarding towing coal and freight in barges is taken largely from records supplied by the Monongahela River Consolidated Coal & Coke Company.

The barges used on the Ohio and Mississippi Rivers and their tributaries may be divided into two classes, namely, the coal barge and the freight barge.

Coal barges are known as gunwale barges, with a scow end. They are 135 feet length, 25 feet width and 8 feet depth, with a normal draft, when loaded to full capacity, of about 6½ feet. The cargo capacity is 550 tons. These barges are constructed chiefly of wood, the side gunwales are 6 inches and 7 inches in thickness, and the bottom and end planking 3 inches. The ends, or rakes, as they are called, are circular, extending back about 18 or 20 feet from the ends. In recent years steel is being adopted to a limited extent in the construction of these barges, which, of course, is very much more desirable than wood, and particularly so for use in a Southern or tropical climate.

The cost of a wooden barge of these dimensions runs from $1,800 to $2 200 (£370 to £450), depending upon the character of material or workmanship. A steel barge of light dimen-

sions would run from about $5,500 to $6,000 (£1,130 to £1,230).

In past years, freight barges have usually been built of wood, with "model" ends, so as to make them tow easily against the current. Their carrying capacity runs from 750 tons to 1,400 tons, and the draft varies from 6½ feet to 9 feet. They cost from $5,000 to $25,000 (£1,030 to £5,140), depending upon the size, character of construction, etc. The tendency now seems to be toward steel for this character of craft, and this is certainly to be recommended for Southern climates and where the facilities for dry-docking and repairing are not so good as they are at Pittsburg. The annual depreciation on a wooden barge is from 7½ percent to 10 percent of its original cost. The question of repairs is a very difficult one to estimate accurately. For instance, during the first five years a wooden barge does not require very many repairs. Thereafter the repairs become very extensvie and expensive. A fair estimate for the average repairs on a wooden coal barge during its normal life is about $200 (£41) a year.

The manner of towing on the Ohio and Mississippi Rivers is unique. The barges are placed in front of the tow boat, the tow being made up in the form of a raft. Two barges are hitched on either side and forward of the tow boat, lapping over the tow boat a distance of about 40 feet or 50 feet, leaving an open space in front of the tow boat for the remaining length of the barges, which are hitched alongside. Then forward of these four barges and the towboat are hitched additional tiers of barges, usually from five to seven in width, and with from three to four length of barges. By means of ratchets and chains they are all bound closely together, forming practically one boat.

The transportation is carried out on what is commonly called "rises" in the river, or, in other words, freshets. The tows are prepared by having the barges loaded and moored at Pittsburg until there is sufficient stage of water caused from rains or melting snows, when the tows are hitched up and sent down the river to their destination. Since the major portion of the barges are returned empty that can be accomplished on a much lower stage of water than is required for carrying the loaded barges down-stream. The average current is usually from three to six miles per hour, depending upon the stage of water and the particular location on the river.

The size of the tows handled by these tow boats varies greatly, depending upon the stage of the water and the particular part of the river. For instance, an average tow from Pittsburg to Louisville, Ky., consists of about seventeen to twenty-four barges, say from 8,000 tons to 12,000 tons; while an average tow from Louisville, Ky., to New Orleans, on the Mississippi River, ranges from twenty-eight to forty-six barges.

The cost of transporting coal from the mines at Pittsburg to Louisville, Ky., a distance of about 650 miles, including all expenses, maintenance, repairs of craft, etc., is about 80 cents (£.164) per ton of 2,000 pounds. The cost of transporting coal from the mines at Pittsburg to New Orleans, a distance of about 2,000 miles, including all expenses, maintenance, repairs of craft, etc., is about $1.80 (£.37) per ton.

There is also a cheap coal boat of 2½-inch hemlock, 175 feet long, 26 feet wide and 10 feet deep, which carries 1,000 tons. These barges are only used for one or two trips and are then sold. They cost from $800 to $900 (£164 to £185), depending on the size and construction.

The largest tow boats have taken down the river from Louisville to New Orleans from 54,000 tons to 56,000 tons, including their fuel. This does not include the weight of the timber in the barges. These boats will bring up the river, against the current, 2,500 tons to 3,500 tons of freight at a speed of from 4 miles to 5 miles per hour on a 6½-foot or 7-foot stage of water.

Since the bulk of freight on the Ohio and Mississippi Rivers is down-stream, the barges for this service, with few exceptions, are not constructed with the easy rake for purposes of towing up-stream.

The tow boats have immense rudder power. Virtually the tow boat is but the rudder of the tow, as it is imposible to steer ahead constantly, owing to the danger of navigation, and the boats are constantly backing and flanking and putting the tow into shape to pass safely the bends in the river. It may be said that from Pittsburg to Cincinnati the engines on the tow boat may be backing one-fifth of the time. It is on account of the immense backing power of these stern-wheel boats that this type of steamboat has been so successful in inland navigation. There is no boat of any design that can compete with the stern-wheel boat in a river where there is a strong current and navigation is as hazardous as it is on the Ohio and Mississippi Rivers, which contain so many artificial obstructions, such as bridges, etc.

The number of the crew to operate these boats depends upon the service. For the small boats it requires two pilots, one acting as captain; two engineers, one mate, one watchman, two firemen, one cook and three deck hands. On the large boats there is one captain, two pilots, two engineers, four firemen, two cooks, one watchman, one mate, and from eight to twelve deck hands.

TOWING ON THE YUKON RIVER, ALASKA.

The manner of towing by barges depends upon the river and the amount of the traffic. On the Yukon River, Alaska, they tow both up-stream and down-stream, and also use a number of freight boats. The season is very short, commencing in June and closing in September. The largest, and one of the best, tow boats on the Yukon is the steamer *Will H. Isom*, 190 feet long on the deck, 36 feet beam, 6 feet depth of hold, 3 feet 6 inches sheer forward, 24 inches aft, having engines 24 inches diameter and 8-foot stroke, with five boilers, 40 inches diameter, 26 feet long. This boat is built of wood and cost $75,000 (£15,400); if built of steel she would have cost $100,000 (£20,500). Her draft is only 3 feet, to enable her to tow in from 3½ feet to 4½ feet of water. The engines are designed to work high-pressure condensing and also non-condensing, since they have to run in salt water. The fuel consumption is from 1,000 bushels to 1,200 bushels of coal per twenty-four hours. She is capable of towing up the river five barges with from 500 tons to 600 tons of freight in each, or, say, 2,500 tons in all.

The barges are 161 feet long, 38 feet beam and 7 feet 6 inches deep, with a cargo box to protect the freight. They are strongly built, to stand the rough water, and have a good rake forward and aft, extending about 20 feet from the ends. The rake starts about 2 feet down from the top of the gunwale. The scow model is used altogether. The draft, light, is 12 inches, and they carry from 150 tons to 160 tons per foot of draft. The load is varied, according to the season, depending upon the stage of the river.

The engines used for this service are mainly the lever-balanced high-pressure poppet valve type, with expansion joint side pipes, which is the simplest engine for the purpose, and it is designed to stand from 150 pounds to 250 pounds pressure. Outside of the wheel shaft, it is a very rare occurrence for one of these steamboats to be disabled by breakage of machinery. The cam motion for the cut-off and the connecting rod for full-stroke motion on all modern boats is now taken from the crosshead, and thus the danger of breakage of cams and connections on the wheel shaft is avoided.

It has sometimes been found essential on the boats used on very wide and shallow, swift rivers, like the Yukon, to place two small balanced monkey rudders aft of the wheel, as well as the main balanced rudders forward of the wheel.

SMALL TOW BOATS FOR USE ON THE MONONGAHELA AND OHIO RIVERS.

These boats range from 125 feet long and 20 feet to 22 feet beam to 140 feet long, and 24 feet to 27 feet beam and 3 feet 6 inches to 4 feet 6 inches deep, with engines ranging from 12 inches diameter by 5-foot stroke to 16 inches diameter by 7-foot stroke. The cost for a small boat of this type, with wooden hull, varies from $20,000 to $24,000 (£4,100 to £4,900), and for the largest from $32,000 to $35,000 (£6,570 to £7,200). Steel-hull boats, with a cabin frame of steel and tandem compound engines, 12 by 24 inches by 6 or 7 feet stroke, cost from $45,000 to $65,000 (£9,250 to £13,350). Boats of this latter type, built by James Rees & Sons for the Vest Coal Company, are 135 feet long, 26 feet beam and 4 feet depth of hold, with engines 12 inches by 24 inches by 6-foot stroke, tandem compound, with surface condenser. The wheel is 20 feet diameter, 16 feet wide, with buckets 36 inches wide, the average revolutions, when towing up or down-stream, being 17 or 18, with 160 pounds steam pressure and 26 inches vacuum. They tow five barges, with a capacity aggregating about 2,500 tons. The cost of towing is about 3½ cents per ton, and including all expenses for labor and repairs, insurance to boats and barges, it is about 4½ cents per ton. These boats can handle double the amount of tonnage, but, on account of the restriction of locks, that is all they are allowed to carry in a single tow.

The flats used by this firm are 100 feet long, 26 feet beam and 8 feet deep, with an 8-foot rake at each end. The cost of these barges is $2,600 (£535) when built of wood, and $5,250 (£1,080) when built of steel. The life of a wooden barge is about fifteen years, and the cost in repairs from $50 to $100 (£10 to £21) per year.

Both tow boats and barges for this service have to be exceptionally strong, as they must contend in winter with ice 8 inches to 10 inches thick. Also the machinery must be perfectly reliable, since they are operated in swift currents, where a single mishap is liable to send the boat over a dam.

SOME DATA ON PADDLE-WHEEL STEAMERS.

BY CLAUDE A. ANDERSON, S. B.

The information to be found on paddle wheels and the performances of paddle-wheel steamers is exceedingly meagre, and what there is rarely has the value of being up-to-date. Having need of more data than could be found in the best text books on naval architecture, the writer collected and compiled for his own use from every source reliable and possible to him what would give an idea of the best marine practice, both foreign and American. The table of figures accompanying this article contains the more complete results found.

As is well known by those who have sought information on the subject, the figures reported are notoriously often far from being actual. And it is with this knowledge that a great part of the data is presented—the writer not being responsible for errors due to false reports. Where variations have been noted for the same dimension, the one more apparently correct has been chosen; and where actual results have been given or the figures known to be correct through personal knowledge, an asterik has been placed opposite the name of boat under the heading "test." Most likely, however, the other figures are not in error to so great an extent but that they possess some value.

The boats chosen are selected as a representative lot, varying in size from the smallest to the largest in use, from the river and harbor excursion steamer to the Channel and the Lake night boats; and in nationality from the American to the English, French and Belgian.

The *Commonwealth* is the largest and latest addition to the Fall River line.

The *Priscilla* and the *Puritan,* of the same line, are also in the Long Island Sound service.

The *City of Cleveland* is the latest passenger boat of the D. and C. line, plying the waters of Lake Erie.

The *Providence,* also a Fall River line boat, runs between New York and Providence.

The *C. W. Morse* is in the Hudson river night service, between New York and Albany.

Hendrick Hudson is in the day line service between New York and Albany.

The *City of Erie* is the largest of the passenger steamers, making nightly trips between Cleveland and Buffalo.

The *New York*, burned to the water's edge in October, 1908, was also of the Hudson River Day line.

The *Tashmoo* is a fast excursion steamer, making daily trips on the Detroit and St. Clair rivers.

The *Jamestown* was built at the time of the Ter-Centennial, to carry passengers between Washington, D. C., and Norfolk, Va.

The *Middlesex* and the *Maryland* are Southern river and harbor steamers.

The *Nantasket, Old Colony* and *South Shore* are three of the excursion steamers making hourly trips between Boston and Nantasket Beach.

The *Isle of Arran,* built by T. B. Seath & Company, of Rutherglen, carries passengers on the waters of the Clyde.

The French steamers comprise a group of Channel steamers built by French shipbuilders and owned by the Northern Railway Company of France.

The *Paris* is a notable example of passenger steamer, built by A. & J. Inglis, of Glasgow.

The *Marie Henriette* is a passenger steamer for Channel service, belonging to the Belgian Government, and a product of the Cockerill Company.

The *Prince Rupert* is a Denny production for the English Channel service, but afterward transferred to Canada, where she now runs regularly between Yarmouth, N. S., and Digby.

Ville de Douvres, built by the Cockerill Company for the Belgian postal service between Ostend and Dover, was one of the foremost examples of her type at the time of her debut.

The *Mary Powell,* while not a feathering paddle steamer, is, nevertheless, included in the list as a boat possessing remarkable qualities as to hull, speed and general performance.

The *City of Alpena,* with her sistership, *City of Mackinac,* is a Lake boat from the design of Mr. Frank Kirby, and follows a course between Toledo, Ohio, and Mackinac Island.

The last example given is one of thirty boats built to the order of the London County Council for passenger trade on the Thames. Some of these boats were built by Thormycroft, but the one here given, and the fastest of the group, was built by Napier & Miller. Essentially river steamers, they have seaworthy qualities and are exceptionally interesting because of the small diameter of their wheels and the high number of revolutions.

As to results and purposes, the table speaks for itself in making comparisons between representative boats of different designers; but a few explanatory notes should be made regarding certain of the results:

(*A*) The peripheral speed in each case is figured on the diameter at the centers of gudgeons, and the slip is figured on the same circle.

(*B*) In the cases of the *Priscilla, Puritan, City of Cleveland, Providence, C. W. Morse, Jamestown, Maryland, Isle of Arran, Paris* and *Marie Henriette* the exact figure for the diameter to the centers of gudgeons could not be obtained, so was figured to be smaller than the diameter over buckets by 42½ percent the double width of one bucket.

(*C*) The block coefficient of the *City of Alpena* is figured for 9 feet 2¾ inches, the designed draft.

(*D*) The Admiralty coefficient $\left(\frac{D^{2/3}S^3}{I.H.P. \times 33{,}000}\right)$ is figured on knots—a figure which does not appear in the table.

For the *Commonwealth,* this coefficient is figured on a displacement of 5,430 tons corresponding to 13 feet ½ inch the measured draft on trial.

The displacement used in figuring the Admiralty coefficient for the *Priscilla* is 4,550 tons, she being presumably on light draft when she made 87¼ miles in three hours and fifty-seven minutes on 23.6 revolutions per minute and 9,000 horsepower.

For a coefficient expressing the relation between the work done on the water by the paddle and the horsepower developed at the engine, the quest has settled back to the expression given in some of the works on marine engineering, viz., $K = \frac{A R^3 D^3 N}{I.H.P. \times 33{,}000}$, in which A is the area of one bucket in square feet; R, the revolutions per minute; D, the diameter to centers of gudgeons or effort; and N, the number of buckets in one wheel. Of the different expressions suggested, invented, and appropriated from authorities for this coefficient, the one here given brings results of the least percent variation between the extreme cases. And so it has been chosen for the table.

The last column of results gives the relation existing between the aggregate paddle area of the two wheels and the cubic number of the hull, taking the length between perpendiculars, the beam and the draft, as the component parts of that number, the A and the N in the denominator representing area of one float and number of floats in one wheel respectively. Where the load and light drafts are both given, the mean is used in this expression.

A glancing survey of the table is sufficient to show that there is certainly a great difference of practice in the design of paddle wheels, but it is the opinion of the writer that not all the examples presented should be given the same measure of respect. It is a matter of experience that many wheels built have been designed in ignorance of that which would produce best results, some being admitted failures, while others, apparently successful, do not stand the test of close analysis, leaving a doubt as to what they might not have done by certain alterations. Such, for instance, is the case of the *Ville de Douvres,* whose paddle area is excessive, and the width of whose paddles is about 5 inches in excess, as was pointed out by former Chief Engineer of the United States Navy Isherwood, in his comments on the trial of that boat.

It is not the object of this article to go into a detailed analysis of the figures in the table, but rather to merely present the evidence in the case, leaving the reader to be his own judge as to the examples most worthy to be followed. Yet, in a general way, there are several observations which, it may not be entirely valueless to note, viz., (*A*) That the relation existing between displacement, speed and horsepower is practically the same for the small boat and the large steamer alike.

(*B*) That the figures would indicate that no well-designed wheel should contain more than one bucket for each two feet of diameter to the centers of gudgeons. All the large wheels follow out this practice, but most of the smaller ones show a tendency to increase the ratio; and to their own loss in efficiency, for with the exception of the *Prince Rupert,* they all make a showing inferior to the large wheels. It may be the contention of the designers of smaller wheels that one bucket for each two feet of diameter will not give sufficient bucket area in the water to transmit the horsepower; yet this boat (*Prince Rupert*), with only seven buckets on a diameter of 14 feet 3 inches, is often called upon to meet the severest conditions to wheels and machinery in her rough passage across the Bay of Fundy, and is most successful. Each bucket is, of course, made sufficiently large to give the proper immersed paddle area. A lesser number of buckets and a correspondingly greater area in each bucket might have produced far better results in the other small wheels than the table shows.

It may not be redundant also to remark that where a less number of buckets is used, just that much weight and cost is saved, to say nothing of the friction reduced by the elimination of one or more sets of moving arms, rods and pins in their bearings, and the curtailment of their resistance through the water.

(*C*) That from the table and from other miscellaneous information not given in the table, seven is conceded to be the smallest number of buckets practicable on a wheel for propulsion. Continuing in the observation of the preceding paragraph, this number would limit the diameter to centers of effort of buckets at 14 feet, which really seems to be the minimum limit for a wheel. Many wheels have, however, been built with a smaller diameter for reasons, such as of securing greater deck room or of reducing the weight overhung from side of ship, for mere appearance' sake and from absolute necessity, which wheels, of course, would not be expected to show such efficiencies as those designed with no limitations on size, and purely for efficiency.

(*D*) That the stroke of engine should not exceed 7/16 the diameter of wheels to centers of efforts.

The paddle wheel as a means of propulsion is one which undoubtedly will not for some time be entirely displaced by the screw, hydraulic jet or other means yet to be devised, and in view of the dearth of reliable data at hand relative to design and performance, it would seem not an unprofitable undertaking at one or more of our model tanks to make a series of experiments on such wheels. Certain firms have made tank investigations more or less extensive for their own benefit, and it will be recalled that in 1836 the French naval marine fitted up two war vessels, counterparts as to hull, boilers and engines, the one with radial wheels, the other with feathering, maintaining practically the same diameters, to ascertain by direct trial their comparative efficiencies. Various runs were made with the boats side by side, but separated sufficiently so that neither would have influence on the other. The outcome of these trials demonstrated the radial wheels to be 23½ percent more efficient economically than the feathering, but because of the incompleteness of the investigation and the fact that the aggregate paddle area of the radial wheel was two and one-half times more than the feathering, the results were not exactly what might be called satisfying; and at this date, especially when paddle-wheel design is more of a science, the results are held to be rather crude.

For a model tank investigation, the following subjects might be presented as a suggestive list:

1. With a wheel of fixed diameter to center of effort and the revolutions of engine constant, the effect on the speed of boat by each addition of one bucket to the wheel, beginning with seven and ending, say, with as many as there are feet in the diameter.

2. With the diameter to centers of effort fixed and the speed of boat kept constant, the effect on the horsepower and the revolutions by each addition of one bucket to the wheel, beginning with seven and ending with the same number as in No. 1 above.

The subjects 1 and 2 may seem to duplicate each other in the conclusions to be arrived at, for with one set of experiments tabulated the other set might be obtained approximately, but for the sake of satisfaction and of check, the investigation of the second set can hardly be considered superfluous and might prove highly valuable.

DATA ON PADDLE WHEEL STEAMERS.

Date.	Name.	Test.	Gross Tons.	O. A. L.	L. B. P.	Beam of Hull.	Beam Over Guards.	Depth at Side.	Draft.
1908	Commonwealth	*	5,980	455′ 2″	437′ 11″	55′ 0″	96′ 0″	22′ 0″	13′ 0″ light. 15′ 0″ load.
1893	Priscilla	*	5,398	440′ 6″	423′ 6″	52′ 6″	92′ 6″	21′ 6″	12′ 0″ light. 13′ 0″ load.
1888	Puritan	..	4,593	410′ 0″	403′ 6″	52′ 6″	91′ 0″	21′ 4″	.....
1908	City of Cleveland	*	4,568	404′ 0″	392′ 0″	54′ 0″	92′ 6″	22′ 0″	.....
1904	Providence	..	4,365	397′ 0″	378′ 6″ at waterline.	50′ 0″	88′ 0″	21′ 10″	12′ 0″
1902	C. W. Morse	*	4,307	430′ 0″	410′ 0″	50′ 6″	90′ 0″	14′ 6″	9′ 0″
1906	Hendrick Hudson	..	2,847	390′ 0″	380′ 0″	45′ 0″	82′ 0″	14′ 4″	8′ 0″
1901	City of Erie	*	2,498	324′ 0″	314′ 0″ on keel.	44′ 0″	77 2′	18′ 0″	10.29′ average.
1887	New York	*	1,974	350′ 0″	330′ 0″ on waterline.	40′ 0″	74′ 0″	12′ 3″	6′ 0″ top of keel.
1901	Tashmoo	*	1,344	308′ 0″	300′ 0″ on keel.	37′ 6″	69′ 0″	13′ 6″	8.29′ average.
1906	Jamestown	*	1,337	262′ 0″	250′ 0″	38′ 0″	63′ 0″	14′ 6″	8′ 6″ average. 6′ 6″ light.
1902	Middlesex	..	.....	207′ 0″	200′ 0″	36′ 0″	59′ 0″	12′ 3″	8′ 6″ load.
1902	Maryland	..	891	.....	180′ 0″	34′ 0″	55′ 6″	10′ 1″	4′ 10″ average.
1902	Nantasket	*	739	203′ 0″	.....	34′ 0″	.....	.....	6′ 3″
1904	Old Colony	*	741	192′ 0″	183′ 6″	32′ 0″	58′ 0″	11′ 10″	6′ 3″
1906	South Shore	*	874	205′ 6″	200′ 0″	32′ 0″	56′ 0″	12′ 0″	6′ 6″
1893	Isle of Arran	..	.....	210′ 0″	.....	24′ 0″	47′ 0″	.....	.....
1898	French Steamers	..	1,700	.....	338′ 0″	34′ 9″	68′ 3″	16′ 3″	9′ 0¼″
1897	Paris	..	.....	292′ 0″	.....	36′ 0″	65′ 0″	13′ 0″	.....
1894	Marie Henriette	*	.....	340′ 0″	.....	38′ 0″	76′ 7″	15′ 0″	8′ 11½″
1894	Prince Rupert	*	.....	270′ 0″	.....	.....	.....	.....	9′ 0″
1890	Ville de Douvres	*	875	.....	271′ 0″	29′ 0″	.....	15′ 6″	9′ 0¾″ mean.
1861 1897	Mary Powell	*	983	300′ 0″	286′ 0″	34′ 4″	64′ 0″	.....	6′ 0″
1893	City of Alpena	*	.....	275′ 0″	266′ 0″	38′ 6″	68′ 0″	15′ 0″	8′ 11″
1905	London County Council	..	.....	.....	130′ 0″	18′ 6″	.....	7′ 0″	2′ 9½″

Date.	Name.	Test.	Displacement.	I. H. P.	Speed in Miles.	Size of Buckets.	Area of Buckets.	Width ÷ Length Buckets.	Dip of Bucket.
							Square Feet.		
1908	Commonwealth	*	5,410 light. 6,410 load.	12,000 max.	23.09 max.	14′ 6″ x 5′ 0″	72.5	.345	.....
1893	Priscilla	*	4,550 light. 5,030 load.	9,000 max.	22.09 max.	14′ 0″ x 5′ 0″	70.	.357	24″ light. 36″ load.
1888	Puritan	..	.....	7,700 max.	21.625	14′ 0″ x 5′ 0″	70.	.357	.....
1908	City of Cleveland	*	.....	6,622	21.	14′ 0″ x 4′ 6″	63.	.321	.....
1904	Providence	..	.....	5,500	19. av.	13′ 0″ x 4′ 0″	52.	.308	.....
1902	C. W. Morse	*	3,300	4,500	19.6 av.	12′ 11½″ x (4′ 6″) (*l*)	58.3	.347	.....
1906	Hendrick Hudson	..	.....	5,000	22.	16′ 6″ x 4′ 0″	66.	.242	.....
1901	City of Erie	*	2,233	6,472	21.76	12′ 0″ x 4′ 0″	48.	.333	14″
1887	New York	*	1,240	2,650 av.	20.59	12′ 6″ x 3′ 4″	41.65	.266	13″
1901	Tashmoo	*	1,224	3,400	21.70	12′ 0″ x 3′ 9″	45.	.312	12″
1906	Jamestown	*	.....	2,000	18.79	9′ 0″ x 36″	27.	.333	.....
1902	Middlesex	..	725 light. 920 load.	1,300	16. light.	8′ 6″ x 36″	25.5	.353	18″ load.
1902	Maryland	..	.....	.....	15.	7′ 6″ x 36″	22.5	.400	.....
1902	Nantasket	*	.....	1,100	15.	8′ 11¾″ x 32¾″	24.35	.301	20″
1904	Old Colony	*	.....	1,000	16. av.	8′ 9″ x 33″	24.1	.314	26″
1906	South Shore	*	630 At 5′ 6″ draft.	1,100	14.9	9′ 6″ x 36½″	28.9	.320	16″ about.
1893	Isle of Arran	..	.....	1,300	16.5	9′ 6″ x 34″	26.9	.298	.....
1898	French Steamers	..	.....	7,000	24.8	14′ 1″ x 4′ 3″	59.9	.302	.....
1897	Paris	..	.....	2,200	18.42	11′ 6″ x 4′ 0″	46.	.348	.....
1894	Marie Henriette	*	1,525	8,134	25.5	15′ 0″ x 4′ 4″	65.	.289	.....
1894	Prince Rupert	*	.....	2,609	20.	13′ 10″ x 3′ 9″	51.9	.271	14″
1890	Ville de Douvres	*	1,090	2,982	19.7	10′ 0″ x 4′ 4″	43.33	.433	17″
1861 1897	Mary Powell	*	800 about.	1,560	19.83	10′ 6″ x 17.7″	15.5	.1405	.....
1893	City of Alpena	*	1,712	2,398	16.991	10′ 0″ x 3′ 6″	35.	.35	7″
1905	London County Council	..	.....	360	14.1	.....	10.	.....	.....

Date.	Name.	Test.	Area Below Center of Effort.	No. of Buckets.	Diameter to Center of Pressure.	No. of Buckets ÷ Diameter to Center Pressure.	Peripheral Distance Between Buckets.	R. P. M.	Peripheral Speed.	Slip.
										Percent.
1908	Commonwealth	*	.425	12	26′ 9″	.450	7.01	29.77	2,502	18.75
1893	Priscilla	*	.....	13	30′ 9″	.423	7.43	23.6 max.	2,280	14.75
1888	Puritan	..	.....	13	30′ 9″	.423	7.43	22.8	2,203	15.75
1908	City of Cleveland	*	.....	11	25.2′ about.	.437	7.20	29.	2,296	19.5
1904	Providence	..	.....	12	26.1′ about.	.460	6.84	.....	.....	.....
1902	C. W. Morse	*	.....	12	26.1′ about.	.460	6.84	27.	2,216	22.2
1906	Hendrick Hudson	..	.....	9	20′ 6″	.438	7.17	40.	2,580	24.95
1901	City of Erie	*	.417	11	25′ 2″	.438	7.20	33.25	2,628	27.
1887	New York	*	.425	12	27′ 0″	.445	7.06	26.63	2,259	19.79
1901	Tashmoo	*	.445	9	19′ 1″	.471	6.67	40.08	2,403	20.5
1906	Jamestown	*	.....	9	14.7′	.612	5.14	53.13	2,458	32.7
1902	Middlesex	..	.....	9	13′ 2″	.683	4.61	45.	1,862	24.34
1902	Maryland	..	.....	12	16′ 6″	.728	4.32	.....	.....	.....
1902	Nantasket	*	.462	10	20′ 2¾″	.496	6.35	28.	1,776	25.56
1904	Old Colony	*	.....	9	17′ 2″	.524	6 00	35.	1,890	25.5
1906	South Shore	*	.480	10	18′ 1″	.553	5.69	31.	1,764	25.65
1893	Isle of Arran	..	.....	8	14′ 10″ about.	.539	5.84	46.	2,145	32.2
1898	French Steamers	..	.....	9	19′ 0″	.473	6.64	52.	3,104	29.8
1897	Paris	..	.....	8	17.6′	.455	6.92	32.	1,772	8.6
1894	Marie Henriette	*	.....	9	18.65′	.482	6.52	52.8	3,096	27.4
1894	Prince Rupert	*	.45	7	14′ 3″	.491	6.40	43.	1,925	8.6
1890	Ville de Douvres	*	.423	9	19′ 2″	.470	6.70	36.82	2,217	21.78
1861 1897	Mary Powell	*	.....	26	31′ 9″ diameter over buckets.	.....	.....	27. av.	.....	.....
1893	City of Alpena	*	.44	10	22′ 6″	.455	7.11	28.5	2,026	26.2
1905	London County Council	..	.....	7	8′ 6″	.824	3.82	69.8	1,864	33.4

DATA ON PADDLE WHEEL STEAMERS—Continued.

Date.	Name.	Test.	Stroke.	Stroke ÷ Diameter to Center of Pressure.	Piston Speed.	Grate Surface.	I. H. P. / G. S.	Draft.	Block Co-efficient.	S^2D^2 / I. H. P.	K.	$\frac{L \times B \times D}{2AN}$
1908	Commonwealth	*	9′ 6″	.355	566′	937.	12.82	.....	.608	209.	1,110	193.6
1893	Priscilla	*	11′ 0″	.358	519′ max.	850.	10.59	.....	.622 load .597	216.	1,170	152.5
1888	Puritan	..	9′ 0″	.2925	....	850.	9.06	Natural	.611	.....	1,233	.....
1908	City of Cleveland	*	14′ 0″	.456	.....	.....	.....	.....	.....	.....	1,241	.....
1904	Providence	..	8′ 0″	.317	464′	.....	.....	.....	.....	.....	.....	.....
1902	C. W. Morse	*	9′ 0″	.345	.....	532.8	10.3	.....	.....	.....	.....	182.
1906	Hendrick Hudson	..	12′ 0″	.46	648′	320.	14.05	.....	.637	242.	1,650	133.
1901	City of Erie	*	7′ 0″	.348	560	.....	.....	.....	.....	.....	1,985	115.
1887	New York	*	8′ 0″	.478	532 H.P.	252.	25.68	Forced	.551	178.2	1,447	135.
1901	Tashmoo	*	12′ 0″	.318	798 L.P	228.	11.58	Natural	.548	251.	2,120	79.25
1906	Jamestown	*	6′ 0″	.3145	481	294.	11.56	Natural	.463	225.	1,618	115.
1902	Middlesex	..	5′ 6″	.374	584	244.	8.2	Natural	.....	.....	1,754	166.
1902	Maryland	..	7′ 0″	.531	630	130.	10.	Natural	.526 load	167.	1,111	117.5
1902	Nantasket	*	9′ 0″	.545	.....	91.	.....	.....	.....	.....	.....	54.8
1904	Old Colony	*	9′ 0″	.446	504	.....	.....	Natural	.....	.....	1,210	.....
1906	South Shore	*	8′ 0″	.466	560	.....	.....	Natural	.....	.....	1 425	84.6
1893	Isle of Arran	..	8′ 0″	.442	496	112.	10.7	Naturla	.629	.....	1,260	72.
1898	French Steamers	..	5′ 0″	.337	460	130.	10.0	.....	.....	.....	1,590	.....
1897	Paris	..	7′ 4.58″	.388	768	516.	13.55	Forced	.....	.....	2,250	98.5
1894	Marie Henriette	*	7′ 0″	.400	448	140.	15.7	Forced	.....	.....	888	.....
1894	Prince Rupert	*	7′ 0″	.375	740	465.	17.46	Forced	.461	178.2	2,075	.....
1890	Ville de Douvres	*	6′ 0″	.421	516	.....	.....	.....	.....	.....	970	.....
1861 1897	Mary Powell	*	6′ 0″	.313	442	235.5	12.67	Forced	.50	177.6	1,391	91.3
1893	City of Alpena	*	12′ 0″	.....	.....	156.	10.	.....	.494	.....	.....	73.0
1905	London County Council	..	7′ 4″ 11′ 0″	.326 .489	418 627	160.	14.99	Forced	.576	191.5	1,167	131.
			3′ 0″	.353	419	25.	14.4	Forced	.....	.....	1,231	48.1

3. It has been assumed in subjects 1 and 2 that the size of paddles have been kept all alike. For the third series of experiments let 1 and 2 be repeated, only with this change, that the aggregate paddle area shall be kept constant. Having decided on the proper area of paddle surface for a certain boat, this series ought to give the proper distribution of that area over the most efficient number of paddles.

4. With the same fixed diameter as in 1 and 2, say, and a given number of buckets, the effect of increasing the immersion of upper edge of bucket from zero to the width of bucket.

5. Having tabulated all the above results and plotted the curves corresponding; and possessing the information thus obtained of the proper number and size of buckets for that diameter of wheel to produce the highest efficiency, to compare this wheel with either a larger or a smaller one, the second wheel to be of a design embodying what, in these preceding subjects, has been shown to produce as near the perfect wheel as possible. This experiment would aim to show the relative benefits to be derived from the large wheel at a lesser number of revolutions and the smaller one at a higher number of turns.

The object of these tests would be, in short, to seek to standardize the paddle wheel; to make it possible for the engineer, confronted with a new proposition, to be able almost immediately to settle on the principal sizes of his wheel, and, having made this decision, to be able to rest reasonably assured that his efforts will not meet with anything other than approved success.

The following data regarding the *Bay State* of the Eastern Steamship Company is also available:

Date	1895
Gross tons	2,211
Length over all	292 ft.
Length between perpendiculars	281 ft. 3 ins.
Beam	42 ft. 1 in.
Beam over guards	72 ft.
Depth at side	15 ft. 6 ins.
Draft, about	7 ft.
Indicated horsepower	1,000
Speed in miles per hour	13.8
Size of buckets	10 ft. 8 ins by 3 ft. 6 ins.
Area of buckets	37.3
Width ÷ length of buckets	.337
Dip of buckets	14 ins.
Area below center of effort	.45
Number of buckets	11
Diameter to center of pressure	22 ft. 6¾ ins.
Number of buckets ÷ diameter to center of pressure	.488
Peripheral distance between buckets	6.42
Revolutions per minute	24
Peripheral speed	1,697
Slip	27.4
Stroke	12
Piston speed	576
Draft	Natural

$$K = 1{,}979$$

$$\frac{L \times B \times D}{2AN} = 104.8$$

In the *Bay State* is found an example of the old-style radial wheels displaced for the feathering wheels. The old wheels were 35 feet 8 inches diameter over the floats and turned 16 revolutions per minute on the average. The new wheels, 22 feet 6¾ inches diameter, to center line of gudgeons turned twenty revolutions on the average, but with only 40 pounds gage pressure on the boiler against 45 pounds with the radial wheels. No trial trip to determine the performance of the engine with the new wheels has ever been made, but it was observed on the first trip out (trial trip so-called) that she made the distance from Boston Light to the lightship (6 miles) in twenty-six minutes at 24 revolutions per minute. Upon this data the foregoing figures are based. The horsepower is an approximation based upon what is done under ordinary running conditions. It will be understood that the higher speed is not attempted with the new wheels, the distance from Boston to Portland, Me. (97 miles), being run in the same average time (9¾ hours) as before. The change in these wheels was made during the winter 1909-1910, and the design is that of the eminent naval architect Stevenson Taylor.

The Gebrüder Sachenberg Aktiengesellschaft, Rosslau, have built for the Venezuelan Republic the shallow draft stern-wheel steamer *Josefina.* This is a steel hull boat 108.4 feet long, 25.6 feet broad, fitted with two longitudinal and five athwartship bulkheads, dividing the hull into sixteen watertight compartments. The hull is thoroughly braced with a system of hog chains, and above the main deck there are an upper deck and a shade deck with limited passenger accommodations. The boiler is located forward on the main deck. It is of the locomotive type, with a fire-box extending below the deck, and designed for a steam pressure of 155 pounds. The engines are located aft on the main deck, one on each side. The high-pressure cylinder is 14 3/16 inches diameter and the low-pressure 23 5/8 inches diameter, the stroke being 43 5/16 inches. The stern paddle-wheel has twenty-four wood buckets, each 9½ inches wide, 8 fet 8 inches long.

STERN WHEEL STEAMERS ON GERMAN RIVERS.

BY OUR BERLIN CORRESPONDENT.

On the Elbe and Oder Rivers, as well as on their tributaries, and the canals connected with them, there are in service a large number of what are called stern-wheel steamers, most of which are used as tugs, while some of them, known as express steamers, are set apart for the direct freight traffic.

The most important shipping companies running steamers of this kind are the Neue Oder-Elbe Reederei at Breslau, Emanuel Friedländer & Company at Zarkau, the Frankfurter Gütereisenbahn-Gesellschaft at Breslau, the Dampfer-Genossenschaft deutscher Strom's und Binnenschiffer at Fürstenberg on the Oder. In addition there are quite a number of stern-wheel steamers owned by minor shipping companies or individual captains.

The building of this type of vessel, which has at present reached a high degree of efficiency, has been developed especially by the following shipbuilding yards: Gustav Fechter, at Königsberg, in Prussia; Gebrüder Sachsenberg, at Rosslau on the Elbe; Cæsar Wollheim, at Cosel, near Breslau. The Cæsar Wollheim yards, especially, have turned out a number of stern-wheel steamers of late years. In addition to the foregoing firms, a number of smaller shipbuilding yards have likewise been building steamers of the same type.

That the stern-wheel steamer has its right of existence beside the side-wheel and screw steamers, found in such large numbers on German rivers, is due to the special conditions of navigation there. The upper course of the Oder is regulated by sixteen towing stages, while numerous sluices are installed also between the Elbe and Oder Rivers and their tributaries. The possibilities of the screw steamer as a tug are limited on one hand by a slight depth of water, and on the other by a high rate of flow. Again, the side-wheel steamer proves too broad in the case of high-powered boats to pass through the sluices. While these two types of vessel are used extensively on the broad and relatively deep lower courses of those rivers, the stern-wheel steamer seems to be adapted, on account of its draft, width, length and engine capacity, to the special conditions of the sluices in the regulated river system, thus creating an extraordinarily convenient means of transport.

The latest vessels of this type are about 165 feet in length, 27 feet in width, 3 feet 3 inches in draft, and have engines of about 750 indicated horsepower. Beside these there are minor craft in various intermediary stages up to about 150 indicated horsepower. As regards the size of these vessels, the limits compatible with the dimensions of sluices have unfortunately been reached, as it is impossible to install more powerful engines in a hull of the above dimensions, and these dimensions may not be exceeded. It may be said in this connection that side-wheel steamers, with engines of 1,000 to 1,500 indicated horsepower, can be found on the Elbe, and especially the Rhine River, but these sizes are admissible only where there is a sufficiently deep and broad channel throughout the course of the river.

The type of stern-wheel steamer in question should not be confused with the craft of a similar kind which is frequently used outside of Europe; in fact, there are, in Asia, Africa, and especially America, thousands of stern-wheel steamers, the smallest of which are built to a large extent in Germany. In America there have been used for many years stern-wheel steamers of particularly huge dimensions and a capacity of 1,000 and more horsepower, but the difference between those steamers and the German craft under discussion lies mainly in the design of the engine plant and propellers.

Stern-wheel steamers outside of Europe have mostly relatively large wheels, with a number of stationary paddles of the arrangement originally adopted for paddle wheels. They

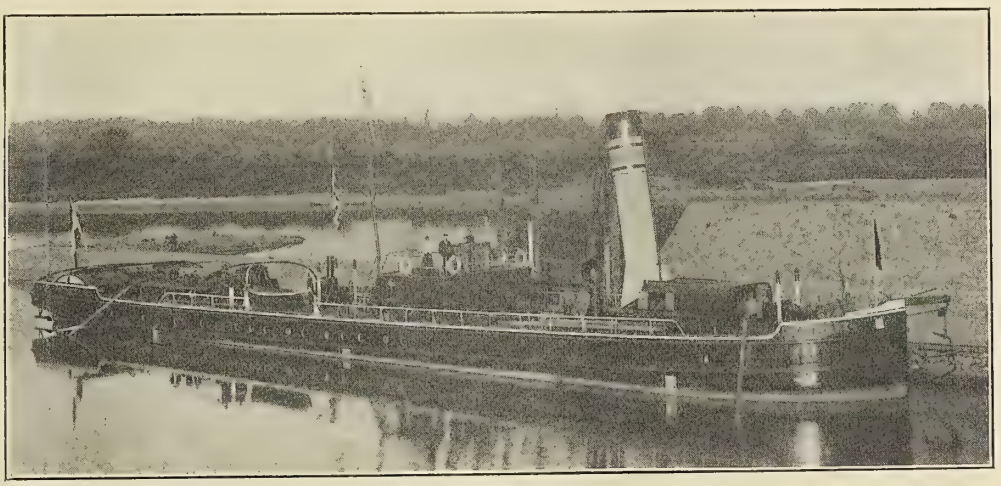


FIG. 1.

are propelled by engines and boilers of the most simple and primitive construction, the boilers being frequently stoked with wood.

German steamers, on the other hand, are equipped with small, light, double-sectioned wheels and movable paddles. The latter are adjusted by means of a lever system, so as always to place the paddle surface vertically just outside the water, and to make immersion and emersion as smooth as possible. Furthermore, the paddles are curved vertically and accordingly are capable of getting a better grip on the water, while exerting a more satisfactory power effect than common radial paddles. This affords a means of securing, with a limited number of paddles and small light wheels, unusually high propulsive forces. These wheels are generally fitted with seven paddles as a maximum.

While this propeller design in itself improves the efficiency of the engine plant, a further improvement, both from a mechanical and economical point of view, is obtained by using the most up-to-date design of boilers and engines. The engines are compounded, and in the case of larger vessels even triple expansion engines, with three cylinders, are used, while the steam pressures are in keeping with this efficiency. Even superheating has been made use of. This accounts for the remarkable economical efficiencies and maneuvering capacities, coupled with a saving in weight and cost.

The cost of a stern-wheel steam tug of from 500 to 600 horsepower works out at about $30,000 to $40,000 (£6,200 to £8,200). As regards the efficiency of some recent boats of this type, the following figures have been given out regarding vessels constructed by Cæsar Wollheim at Cosel, near Breslau.

The steam tug *Altmark* (Fig. 1) plies mainly on the Elbe and Oder Rivers, and the main waterways connected to them. She is of about 35½ inches draft, and is capable of an output of about 490 indicated horsepower for towing purposes. This is sufficient to enable her to tow a train of sixteen empty barges, 5,000 tons in total weight, at a speed of about 2.7 knots, in fifty-nine traveling hours, from Fürstenberg to Breslau, while using up only about 23.5 tons of coal on this journey. The coal consumption per hour thus amounts o about 1.76 pounds for each horsepower.

The steam tugs *Saale* and *Imperator* (Fig. 2) travel mainly on the Elbe River, conveying on the Hamburg-Magdeburg line tows aggregating 3,260 to 3,750 tons in weight. Their coal consumption, with a 50 percent charge in the high-pressure cylinder, works out at about 1.72 pounds per indicated horse-power-hour, inclusive of the consumption corresponding to the steam rudder, etc.

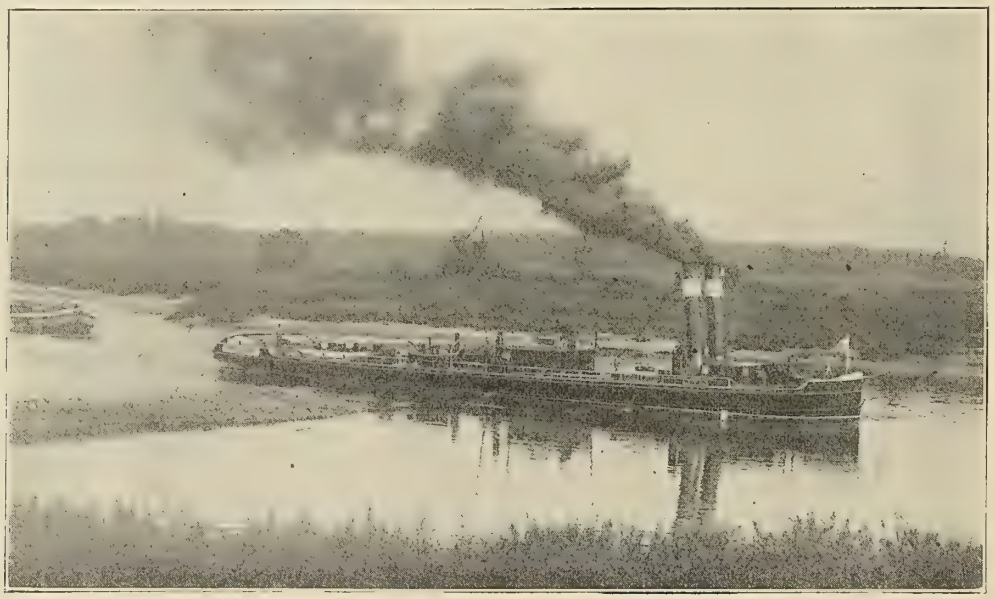


FIG. 2.

The steamships *N. O. E. R. III.* and *Johanna*, traveling on the Oder River, with a coal consumption of from 1.76 to 1.81 pounds per horsepower-hour, have towed eight and more barges of about 2,200 tons from Stettin to Breslau, against rising middle water, at an average speed of 2.26 knots; the coal consumption including losses for the steam rudder, cleaning of the fires, etc. Coal of Upper Silesia is used for boiler stoking.

The following is a short description of a typical large-sized up-to-date German stern-wheel steamer:

The length between the stem and stern post is 165 feet 8 inches, the width on the frames 25 feet 10 inches, the maximum width above what are called the hawse-pieces 26 feet 10 inches, the height on the sides 7 feet 5 inches. The draft of the vessel in working operation, inclusive of the towing attachments, spare parts and 20 tons of coal on board, is about 3 feet, the highest fixed point lying 11 feet as a maximum above water.

The hull is made of first-class German Siemens-Martin ingot iron, the stem and stern post being made up of angle irons and plates. The rudder, about 16 feet 6 inches in length, is made of a welded frame, with iron plating and fir wood filling, and is actuated through chains and levers by a steam-operated steering engine, or by a hand-steering gear from the flying bridge.

The frames are made up of 2½-inch by 2-inch by 3/16-inch angles, spaced about 20 inches apart. In the fore-and-aft parts of the ship there are fitted reverse frames for reinforcing the structure. In addition there is fitted on an average to each fourth or sixth frame a web frame made up of plates about 8 inches in width and 5/32 inch in thickness, with 1¾-inch by 1¾-inch by 5/32-inch angles, continued as a complete frame also below the deck. The floor plates are 8 inches by 5/32 inch, on the upper edge of which are angles, 1¾ inches by 1¾ inches by 3/16 inch. In the boiler and engine rooms, the floors are properly reinforced in accordance with the greater weights. Deck beams of 2½-inch by 2-inch by ¼-inch angles are fitted to each frame. The longitudinal bond of the vessel is designed very carefully, so as to deal with the heavy weight of the boilers and engines located at the ends of the hull, which cause excessive strains.

The outside plating consists at the bottom of plates ¼ inch, and on the sides of plates 3/16 inch in thickness. The seams are single-lap riveted, and the joints double-lap riveted. The deck consists of 3/16-inch corrugated sheets. At the bottom are fitted three intercostal keelsons, below the deck three fore-and-aft carlins, and on each side of the vessel one lateral stringer of similar construction. The stringers and keelsons are substantially connected with the web frames and six transverse bulkheads. Furthermore, the central keelson is connected as efficiently as possible with the central fore-and-aft carlin of the deck, by diagonal bars and longitudinal bulkheads. Deck stanchions, consisting of gas-pipes and angle or T-irons, are also distributed conveniently throughout the ship.

The after third of the ship's length is occupied by the engine room. At the after extremity, the shape of the vessel is drawn in so as to leave room on each side for a paddle wheel of about 8 feet width. Midships are fitted the cabins, comprising quarters for two machinists, a room for the pilot, and a kitchen for the machinists. A special staircase leads down to the captain's and owner's room. In a deckhouse, situated above, are installed the steam-operated steering engine, the men's kitchen and mess, two lavatories and a lamp chamber.

Above the deckhouse is installed the flying bridge, with the hand-steering apparatus. In front of the cabins there is a small hold, 10 feet in length, and in front of this the coal bunker, 16½ feet in length, designed for storing about 55 tons of coal. In front of the bunker is situated the boiler room, which, in order to allow for sufficient height for the boilers and steam accumulators, is covered over with an iron hood. In front of the boiler room are found the two state-rooms set apart for the three boatswains and three stokers. The peak of the ship is designed as a watertight trimming tank, being provided with the necessary piping for this purpose. This tank is designed for storing up to 10 tons of water, with a view to compensating any alteration in the draft of the ship, as produced by the consumption of coal.

On the fore-deck is installed a steam-operated windlass, with spindle brake, two chain discs and two windlass heads. This is also designed for hand operation. On the after-deck is installed a hand-operated capstan.

The towing attachments comprise a well-moored rope clamp and spindle, a double towing bollard and a winch for drawing in the towing rope mounted behind the flying bridge. From the rope clamp the rope is taken over an iron-pipe towing pillar, which can be shifted by means of chains and rollers and a winch. The head of this towing pillar is provided with a roller guide. Above the after part of the ship are installed four gas-pipe towing bitts for guiding the towing rope, parts of which are readily removable.

The engine is an inclined triple-expansion three-crank engine, the intermediate and low-pressure cylinders being arranged beside one another, and the high-pressure cylinder in the center and in front of the same. The cylinders are 16½, 24 13/16 and 41 inches in diameter, respectively, with a stroke of 55⅛ inches. The output, with a charge of about 60 percent in the high-pressure cylinder, is about 600 indicated horse-power. The high-pressure and intermediate-pressure cylinders are provided with steam jackets, which, however, can be cut out. The valve gear is of the Joy type, a steam engine being used for reversing, according to the "all-round" system. The air pumps, bilge pumps and feed pumps are mounted on the front extension of the piston rods of the middle and low-pressure cylinders.

The two 7/16-inch sheet steel paddle-wheels are about 13 feet in diameter, and are fitted with seven paddles, each 8 feet by 3 feet. The hubs and eccentric rings for operating the paddles are of cast steel. The rods are of soft wrought iron of high strength and malleability, the bolts of steel and the bolt bushes of hard phosphor bronze.

The condenser is of the jet type, a pre-heater (which can be cut out) serving to heat the feed water. The steam is generated by two return-tube cylindrical boilers, placed beside one another, with a total heating surface of about 2,000 square feet, operating at a pressure of about 200 pounds per square inch. The steam is led into a common steam accumulator.

The main steam piping between the boilers and engine, as well as the auxiliary steam and feed pipes, are patent welded iron pipes with welded-on flange rings. These pipes are located in a special iron tube channel below the deck, which is provided with the necessary admission openings.

A steam donkey pump is used for boiler feeding and deck washing, as well as for a bilge and fire pump. There is also a boiler feed injector, a pressure pump and a small hand pump for filling the boiler, as well as a bilge pump ejector.

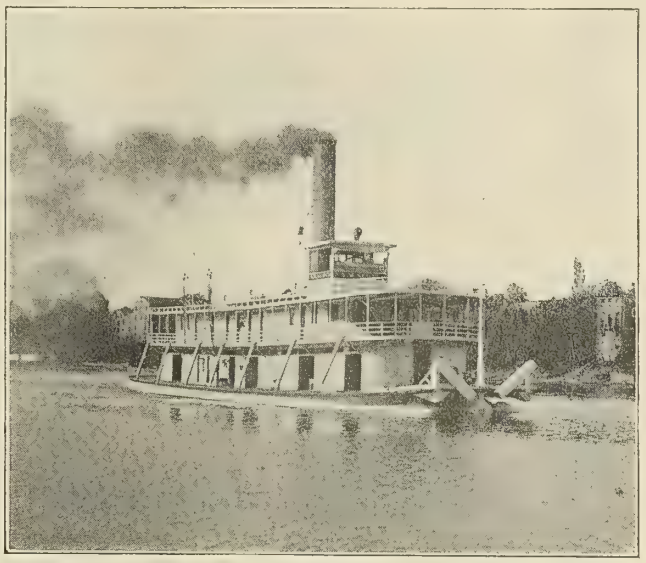
The Bureau of Navigation reports that 125 sail and steam vessels of 42,745 gross tons were built in the United States and officially numbered during the month of September, 1910. Five steel steamers, aggregating 23,754 gross tons, were built on the Atlantic coast.

TWIN SCREW TUNNEL STEAMERS VS. STERN-WHEELERS FOR SERVICE ON THE WESTERN RIVERS.

BY CHARLES E. WARD.

The conditions governing the navigation of the Western rivers of the United States are peculiar, demanding a steamer of good carrying capacity on a limited draft, with the ability to make quick landings at any point along the river. As only the larger towns and cities have wharf boats many landings must be made head-on the bank.

These requirements have developed a type of steamer having handling qualities that until recently have never been equaled. The limited draft necessitates a flat bottom and full, flaring bow, the model being under instead of around. As the stern-wheel is the accepted method of propulsion, and the engines are placed aft, a full stern must be provided to carry



TWIN-SCREW TUNNEL STEAMER A. M. SCOTT.

the excessive weights. This is counterbalanced to a great extent by locating the boilers well forward. Longitudinal stiffness is obtained by a system of hog chains and braces.

Large balanced rudders, from two to four in number, are hung from the transom, forward of the wheel, and are, of course, most efficient when the boat is backing. It is this feature that gives the quick-handling qualities, and enables them to back away from a landing and straighten up on their course with the least possible delay.

The Western river tow usually consists of from sixteen to twenty-four barges, 26 feet by 135 feet, loaded to 6 feet draft, all securely chained together, and the towboat is rigidly fastened to the stern of the tow and pushes them ahead.

The problem of steering these large tows, especially when loaded, going down stream, demands serious consideration; it is this condition that the stern-wheel towboat has met, but at a cost which few, if any, realize. For instance, when approaching a bend in the river the rudders are put hard down to port or starboard, the engines then working astern at from half to full power, the current from the paddle-wheel acting on the rudders throws the stern of the boat and tow in the desired direction, the current then swings the body of the tow into the channel; the engines are started ahead until it is necessary to change the course, when the headway is again checked in order to accomplish results that should be obtained without appreciable loss of headway and power. Fully one-eighth of the time is spent in backing and flanking the tow

around bends and through chutes, a most extravagant waste of power and fuel, as the engines invariably work at full stroke (no cut-off) when backing.

The engines are generally high-pressure, non-condensing, located aft on each side, with long connecting rods to the cranks, which are at right angles on each end of the shaft. With 200 pounds steam pressure, cut-off at from one-half to three-fourths of the stroke, economy is out of the question. Some of the recently-built steamers, especially the larger towboats, have tandem compound-condensing engines, which are, of course, more economical, though still far behind the results obtained with the use of triple-expansion condensing engines.

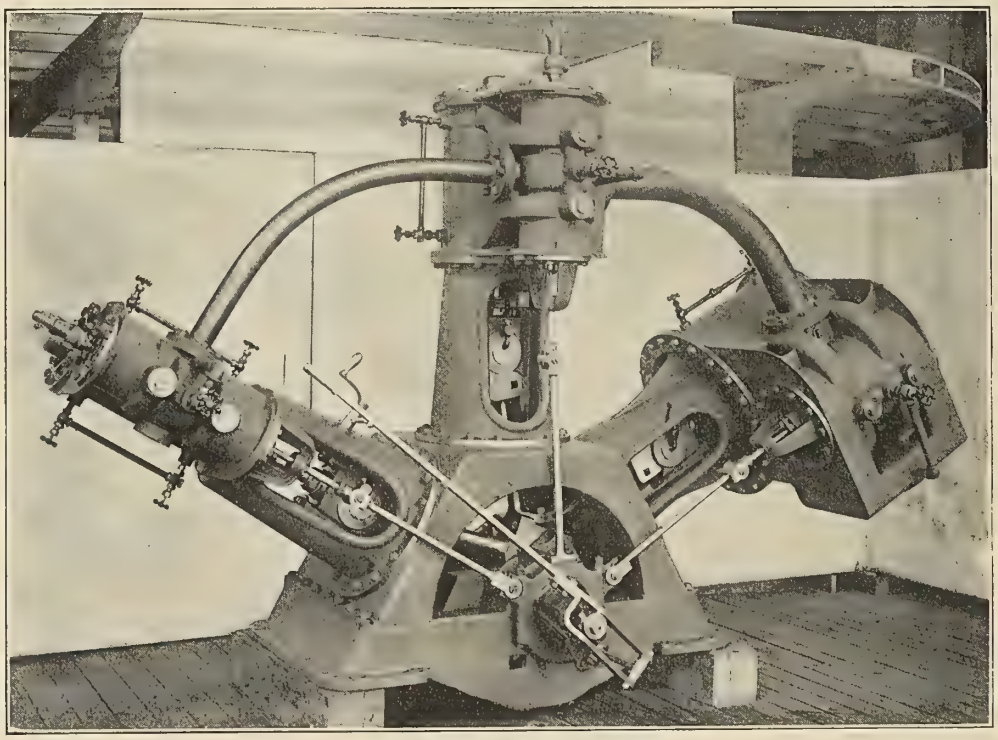
River men resent any effort to supplant their useful, though extravagant, stern-wheelers, even though the change means a saving of nearly half the fuel bill, a sum that would buy a new boat in less than six years' running time.

Tunnel boats have been in use for a number of years abroad, many of them for service on the Nile, built by Yarrow & Company and Sir John I. Thornycroft. These boats have given excellent results in speed and economy, but they do not possess the necessary handling qualities for service on the rivers of the United States.

Realizing the necessity for improvements in shallow draft river steamers, the writer has devoted considerable time and study to the development of the tunnel boat for towing and passenger service, embodying the desirable features of the stern-wheel boats now doing such excellent work, and obtaining economy in fuel and operating expenses that demands serious consideration. In the last few years the Charles Ward Engineering Works has designed and built six tunnel boats, all of them being in successful operation at various points on the Western rivers. The latest addition to the fleet is the steamer *A. M. Scott,* a twin-screw tunnel towboat, 150 feet long; 26 feet beam molded; 28 feet beam over the guards; depth, molded, 5 feet; sheer forward, 2 feet; sheer aft, 1 foot 6 inches; draft, with 70 tons of coal in bunkers, 3 feet.

The under body and tunnels are of special design to give easy run to the propellers and room for the four rudders, which are located in the tunnels forward and aft of the propellers, thus utilizing the full force of the stream of water from the wheels, either ahead or astern. This is a decided improvement over any other type of tunnel steamer, and possesses all the advantages of the stern-wheel towboat when backing or flanking, and gives the greatest possible rudder power when going ahead, due to the action of the wheel water on the after rudders. The rudders are so powerful that the boat can steer her tow through many places that a sternwheel boat would have to stop and flank into position. Maneuvering trials have shown that this boat, when backing and swinging hard to starboard or port, will change and swing in the opposite direction by simply reversing the rudders without stopping the engines.

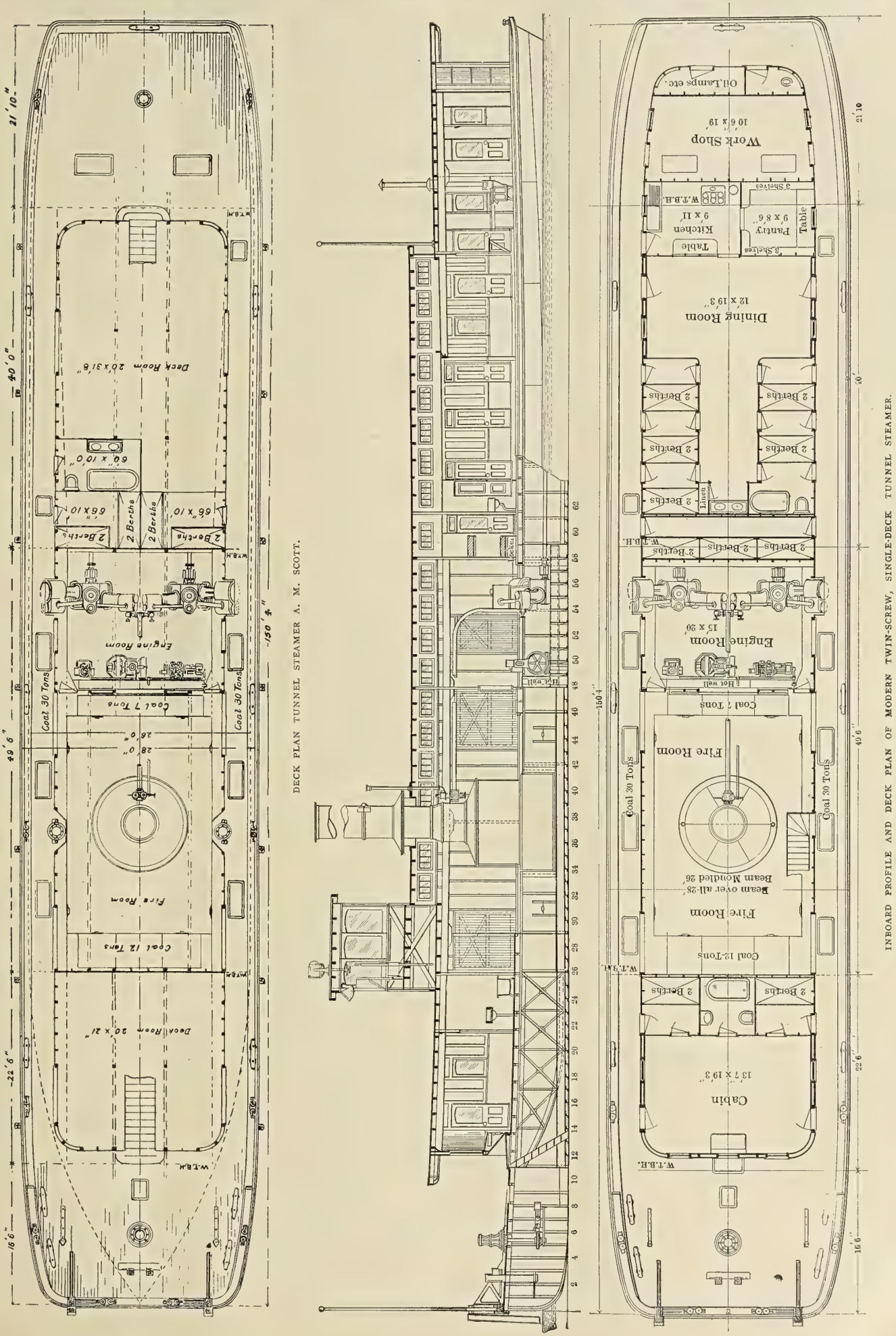
The propellers are 5 feet in diameter, spaced 11 feet 6 inches from center to center, thus giving a twisting power by backing on one engine and going ahead on the other, which will lift the boat's head to port or starboard, a most desirable feature if hemmed in—bow and stern—by barges.



SINGLE-CRANK TRIPLE WARD ENGINE.

The engines are triple-expansion condensing, having cylinders 9 inches, 14½ inches and 25⅝ inches diameter by 14 inches stroke, of special design to secure the highest economy and simplicity. As shown in Fig. 2 the piston valves are operated by a single eccentric and three eccentric rods; the reversing and cut-off being obtained by sliding the eccentric across the shaft. A single-throw crank shaft eliminates four main bearings and their up-keep. The simple valve gear dispenses with five eccentrics, their straps, three pairs of links, reverse shaft, bearings and levers—a direct saving in moving parts, resulting in much more efficient operation and reduction in maintenance. An oil pump, driven by the low-pressure eccentric rod, furnishes ample lubrication under pressure, the oil returning to the crank case and being used again.

A Ward watertube boiler, having 3,000 square feet of heating surface and 100 square feet of grate, furnishes steam at 275 pounds pressure, with natural draft, on a coal consumption of about 1,500 pounds per hour.



DECK PLAN TUNNEL STEAMER A. M. SCOTT.

INBOARD PROFILE AND DECK PLAN OF MODERN TWIN-SCREW, SINGLE-DECK TUNNEL STEAMER.

The condensers are of the outboard sectional type, with provision for reducing the cooling surface in the winter.

The exhaust steam from the auxiliaries is passed through a feed-water heater and from there direct to the hot well, making a most efficient feed-water heating system.

The boiler and engines are located mid-ship, as shown on deck plan (Fig. 3), and occupy less than 50 feet length of boat. Coal bunkers of ample capacity are arranged all around the boiler, thus avoiding the usual fuel boat and coal passers.

The hull is of the best open-hearth steel plate, built on a substantial framing of steel angles, Z-bars and channels. Two longitudinal bulkheads provide ample stiffening, no hog chains or braces being necessary.

The cabin and deck house conform with the usual practice of the Western river steamers. If desired for navigation in rivers obstructed by low bridges the necessary accommodations can be had on the main deck, as in the modern twin-screw river towboat (Fig. 4).

The steamer *A. M. Scott* develops 700 horsepower and possesses many advantages over the regular stern-wheel steamer, the greatest being the reduced coal consumption, due to the economical type of machinery, obtaining the greatest power on the least displacement, resulting in a direct saving in power required to propel the boat alone of nearly 50 percent, as a stern-wheeler of the same power will have about double the displacement. Due to the special form of the stern and location of the rudders, the *Scott* is a decided improvement, and has demonstrated the fact that a tunnel boat can be built with all the handling features of a stern-wheeler and possessing many qualities peculiar to the tunnel boat that cannot be had with any other type.

The steamer *Robert P. Gillham,* owned by the Campbell's Creek Coal Company, represents the most recent practice for stern-wheel towboats, and as she has slightly more power than the tunnel steamer *A. M. Scott,* a brief description and comparison of the two boats will be of interest.

The *Gillham* has a wood hull 150 feet long, 172 feet over all, 31.8 feet beam, 4 feet 6 inches deep, and has a draft of 4 feet 3 inches, when fully coaled, on a displacement of over 500 tons. The main engines are double-tandem compound condensing, 14 inches and 24 inches diameter, with a stroke of 7 feet, coupled at each end of the shaft to cranks at right angles, turning a paddle-wheel 19 feet in diameter, 22 feet face, having fifteen buckets 30 inches wide. The steam and exhaust valves are of the balanced poppet type, operated by the McConnel inside cam valve gear, giving variable cut-off from about three-eighths to full stroke. A duplex plunger pump, with plungers 4½ inches diameter by 10 inches stroke, is used for feeding the boilers. The circulating water, after leaving the condenser, is piped about 80 feet forward to the ash-pan, which is constantly flooded, the ashes being washed overboard through an ash chute.

There are four horizontal cylindrical boilers, each 38 inches diameter and 28 feet long, with two flues 14 inches diameter in each, giving 1,750 square feet heating surface. They are set in battery with the usual firebrick and sheet iron casing. The furnace is 16 feet wide with grates 4 feet long. Two mud-drums are placed athwartship, one just aft of the furnace and the other near the end of the boilers, and a steam drum extends across the top of the boilers, which are connected to the mud and steam drums by large water and steam legs. As the engines are condensing, the exhaust cannot be used for forced draft, which is obtained by eight steam jets, one at the end of each flue. The draft is sufficient to burn from 40 to 45 pounds of coal per square foot of grate per hour.

Indicator cards from the *Gillham's* engines, while making a trip up the Ohio River with a tow of twenty-four empty barges, each 26 feet by 135 feet by 18 inches draft, and two fuel boats, give a total of 770 horsepower at twenty revolutions and 200 pounds steam, with a coal consumption of about 800 bushels in twenty-four hours, or 2,660 pounds per hour, or 3.4 pounds per horsepower. The coal is carried in a small barge or fuel flat, and passed in wheelbarrows to the fire-room, each barrow holding approximately 2½ bushels, requiring about 336 barrows each twenty-four hours, which is somewhat in excess of the 800 bushels given.

The main deck is devoted almost entirely to machinery, boilers and coal, thus occupying about seven-eighths of the length of the vessel, a condition that would not be tolerated in any other service.

The following table gives the principal dimensions and salient features of the two types of steamers, and shows at a glance the enormous saving by the adoption of tunnel boats using watertube boilers and the most economical engines:

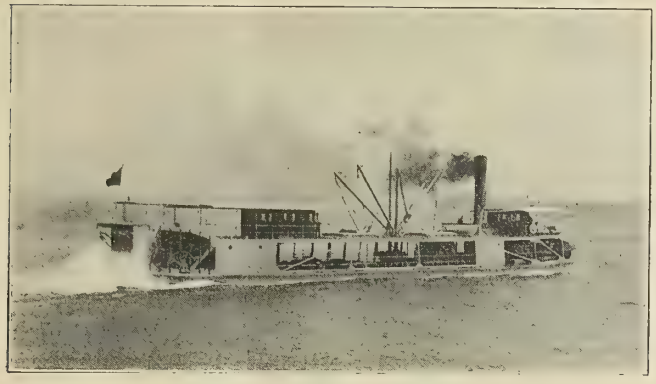
	Stern Wheel Steamer R. P. Gillham.	Twin Screw Tunnel Steamer A. M. Scott.	Saving in Favor of the Tunnel Steamer.
Length over all	172′	151′	21′
Length between perpendiculars	150′	150′	....
Beam	31′ 8″	26′	5.8′
Beam over guards	....	28′	....
Depth	4′ 6″	5′	....
Draft fully coaled	4′ 3″	3′	1′ 3″
Displacement, tons	500	225	275
Speed, miles per hour	12	15	3
Engines	(2) 14″ 28″ 84″	(2)9″ 14½″ 25⅝″ 14″	....
Indicated horsepower	770	700	....
Steam pressure, pounds	200	275	....
Boilers	4—Cylindrical 38″ x 28′	1—Water Tube	....
Heating surface, square feet	1,750	3,000	....
Grate surface, square feet	64	100	....
Space required for engines, boilers and coal, square feet	3,740	1,000	2,740
Coal consumption per hour, pounds	2,660	1,500	1,160
Coal per square foot grate	41.5	15	....
Coal per horsepower per hour	3.4	2.14	37%
Cost of fuel per year, 300 days, $2 (£.41) per ton	$17,152 (£3,520)	$10,800 (£2,220)	$6,352 (£1,300)
Cost of labor to handle 3,176 tons of coal (3 or 4 times) not required for tunnel boat	....	....	$1,270 (£260)
Number of bearings to adjust including valve gear	112	22	90
Number of stuffing boxes	28	12	16
Flange joints on engines	68	34	34
Number of barges including steamer that can pass through locks	2	3	1

STERN WHEEL STEAMER AXHOLME.

The sternwheel steamer *Axholme,* built for Messrs. John Holt & Company (Liverpool), Ltd., by Messrs. Cammell Laird & Company, Ltd., at their Tranmere Shipyard, Birkenhead, was delivered in the River Mersey, boarded up for the voyage to the Niger. Previous to this the *Axholme* went through her trials in the Mersey in boisterous weather and proved herself efficient both in speed and steering capabilities.

The dimensions are 141 feet by 25 feet by 5 feet 6 inches. She has a main and upper deck; the upper deck stringer and curlin is made extra strong and supported and tied by T-bars to form a good girder.

The accommodation for crew is arranged under a monkey forecastle. Cabins for the pilot and engineer are aft, in steel houses. There are also galleys for both Europeans and natives, a bath room, toilets and stores in steel houses on the main deck. On the upper deck aft is a capacious cabin for agents and others, built of teak. Forward is a cabin of teak for the captain. Both of these cabins are nicely fitted up and upholstered. A shade deck is fitted over these deckhouses, and kept well over the roof of the cabins, to ensure a current of air passing over them to keep cabins as cool as possible. Can-



A LIGHT BRITISH-BUILT RIVER BOAT.

vas curtains are fitted all around vessel, both for the main and upper deck, to give protection from heat and rain.

Especial attention has been paid to ventilation on the lines of Prof. Ross's recommendation for the prevention of African fever, and measures have been adopted by which the crew of the vessel, both European and native, are protected from the bites of mosquitoes and other tropical insects.

The machinery, also built by Messrs. Cammell Laird & Company, Ltd., consists of compound surface condensing engines having cylinders 15 inches by 30 inches by 42 inches stroke. The boiler is of the locomotive type, having ample heating and grate area. The builders guaranteed a light draft, deadweight on 4 feet, and speed loaded, all of which were successfully attained with ease. The vessel and engines were built under the supervision of Messrs. A. C. Hay & Smart, consulting engineers for the owners.

This boat is the first of her class built for the transport service of the River Niger, and is specially intended for handling cargo of all kinds with despatch, being fitted with powerful winches for this purpose, as well as for hauling the vessel off banks whenever she gets aground. By those well acquainted with the river, this boat is considered one of the most efficient and up-to-date vessels built for the trade. She was towed from Liverpool to the Niger by one of Messrs. John Holt & Company's ocean steamers, the *Balmore*.

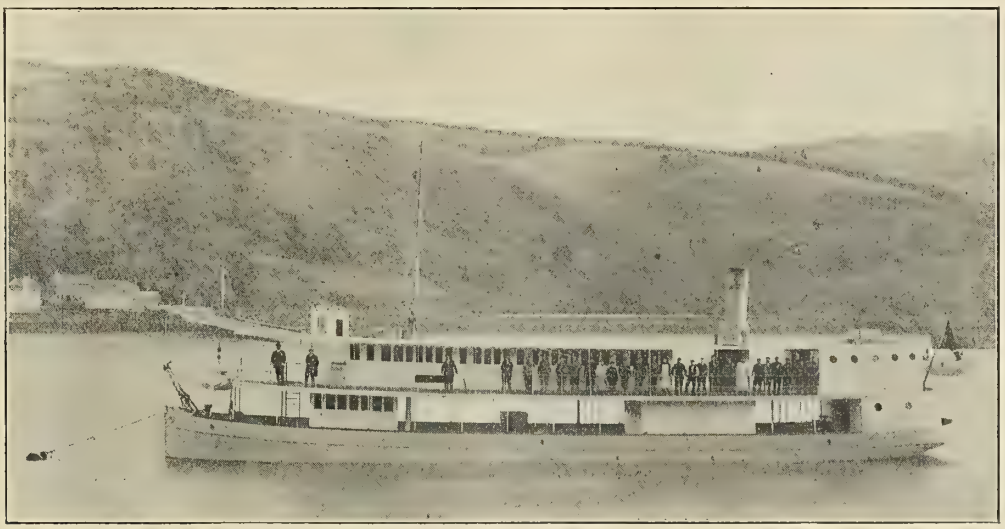
The new 45,000-ton White Star Liner *Olympic* was launched successfully at the Harland & Wolff Shipyard, Belfast, October 20.

Twin Screw Shallow Draft Steamer Diego Martinez.

The *Diego Martinez* is a twin screw shallow draft steamer, built by Messrs. Philip & Son, Ltd., of Dartmouth, for passenger and cargo service at Cartagena, South America. The principal dimensions are: Length over all, 115 feet; length between perpendiculars, 110 feet; beam, molded, 20 feet; depth, molded, 7 feet; draft with passengers, stores coal, water and 150 tons of cargo on board, 5 feet. Under full load conditions, in fair weather the vessel averages 9 knots. The machinery consists of two sets of compound surface condensing engines and two return tube marine boilers, the working pressure of which is 130 pounds per square inch. There is one condenser common to the two main engines and the air and circulating pumps are of the independent duplex double-acting horizontal type.

The hull throughout is built entirely of steel with a steel main deck and teak upper deck. The passenger accommodation is made suitable for hot climates, the first class passengers being housed on the upper deck and the third class passengers on the main deck.

The vessel steamed from the builders' works to Cartagena without mishap, coal and stores sufficient for the voyage being carried in the hold.



THE DIEGO MARTINEZ, BUILT IN ENGLAND FOR SOUTH AMERICAN SERVICE.

THE MACKENZIE RIVER.

Going back over records of stern-wheel steamboats, which have been designed and built in accordance with plans and specifications furnished by Marine Iron Works, Chicago, there is none that seems to be of greater interest than one completed about two years ago, now in operation in the far northwestern part of the North American Continent. The hardships and difficulties met in transporting machinery, as well as parts of boats in this country, are of a character that would cause a great many to hesitate in going ahead with the project of building a boat for this service.

The craft that we have in mind is the *Mackenzie River*, owned by the Hudson's Bay Company, which was constructed at Smith's Landing, situated at the head of the great chain of lakes and river navigation, extending northward without obstruction for a distance of 1,800 miles through comparatively wild and barren territory, emptying into the Arctic Ocean. This far northern region is sometimes designated as the "Land of the Midnight Sun," on account of the fact that, during the summer months, commencing with June, there is continuous sunlight, and during the longest day the sun does

not go below the horizon. This gives one a faint conception of the long distance that a boat the size of the *Mackenzie River* had to travel before it finally reached the point where it was to be built, and the difficulties encountered in transporting it from the Great Lakes region of the United States to its destination, where it was erected and the machinery installed and placed in operation.

The steamer *Mackenzie River* is of the stern paddle-wheel type, and of the following dimensions:

Length on deck	125 feet
Beam outside of planking	26 feet
Depth, forward	7 feet 10 inches
Depth, minimum	5 feet 4 inches
Dead rise	8 inches
Flare in sides	3 inches
Block coefficient up to 32-inch waterline	57.3 percent
Draft, steam up ready for load	32 inches
Draft, 100 tons cargo aboard	4 feet

The stem is a 10-inch by 20-pound channel. The frames, spaced 12 inches, 16 inches and 18 inches heel to heel, are formed of 3-inch by 2-inch by 5/16-inch angles, every frame having a 3-inch by 2-inch by ¼-inch continuous reverse frame carried up past the turn of the bilge. The deck beams are 2½ inches by 2 inches by ¼ inch riveted to the top cords of the trusses and to the side frames, with 5/16-inch bracket plates. These deck beams are laid bosom up and are filled with 2½-inch by 5½-inch wood deck beams. There are two side trusses and one center and two wing trusses, built under the center and side hog chain systems. Each truss is formed as follows:

The top cords are composed of two 4-inch by 3-inch by 5/16-inch angles, back to back, riveted to the deck beams. The bottom cords are composed of two 4-inch by 3-inch by 5/16-inch angles, back to back, riveted to the reverse floor frames.

The struts, of lattice construction, are formed of 2½-inch by 2½-inch by ¼-inch angles, fastened to the top and bottom cords, and are fastened together where they cross by 5/16-inch thick plate brackets.

The deck stringers are continuous fore and aft from stem to stern. They are of 33-inch by ¼-inch plate, with the inside edge riveted to the outside cord of the wing truss.

There are two fender angles on each side, 3 inches by 2 inches by 5/16 inch, continuous from stem to stern.

The keel and bilge plank is 2¾ inches, the bottom and side planking 2½ inches. The strength and safety of the hull are increased by five watertight compartments.

On the main deck is a commodious house containing cargo space in addition to the machinery and crew's quarters at the after end, also a kitchen, pantry, toilet room, etc. Above this, on the upper deck, is a commodious house containing a dozen staterooms for passengers, a large dining room, handsome smoking room at the forward end and ladies' cabin aft. Above the second deck is located the master's room and pilot house, which is designed for convenience and comfort.

The hull of the vessel is of light construction, special steel being used to enable her to navigate safely the waters of the Mackenzie River. Longitudinal strength has been adequately provided in the form of five lattice girders and numerous hog post ties. Bulkheads provide for ample transverse strength. The bow has been made especially strong to resist the impact of ice, snags, etc. Frequently, even in mid-summer, while crossing the Great Slave Lake, immense fields of ice are seen or encountered.

At 4-foot draft of water the steamer will carry 60 tons of deadweight cargo, in addition to 30 tons of fuel.

The machinery consists of a pair of Marine Iron Works, direct-acting modern stern paddle-wheel marine engines, capable of being worked up to and over 250 horsepower. Each engine cylinder is 12 inches diameter by 60 inches stroke, and is fitted with a piston valve for the high working pressure which it is consistent to carry on machinery of this character.

FIG. 1.—TRANSPORTING THE BOILER ACROSS THE PLAINS.

The boiler is a horizontal locomotive fire-box, direct-draft marine type having a large deep fire-box for burning wood, and, being built under the Canadian marine rules and regulations, licensed to carry 180 pounds steam pressure.

The boat is also fitted with a special design of steam capstan of the double-drum type, operated by a pair of double-acting 5-inch by 7-inch engines.

The paddle wheel is 16 feet diameter by 16 feet long, strongly built, well ironed, and under normal conditions will make about 27 revolutions per minute.

Everything connected with the work was made to comply

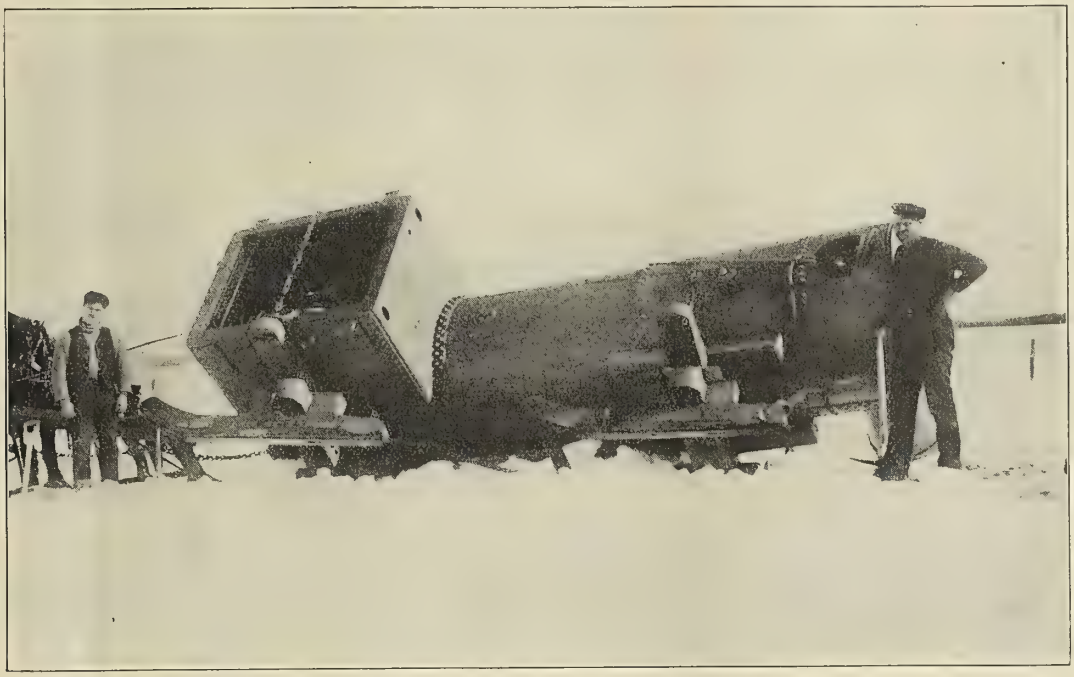


FIG. 2.—UPSETTING OF LOAD; ONE OF THE DIFFICULTIES IN DELIVERING TO RIVER LANDING.

with the Canadian marine rules and regulations and to the satisfaction of the Hudson's Bay Company's representative.

The hull of the *Mackenzie River* is composite construction —steel framework, wood planking. All of the steel framework was fabricated at the plant of Marine Iron Works, loaded with the machinery on cars and delivered by railroad to the town of Edmonton. From Edmonton to Fort Smith the real hardships and difficulties of the job began, as from this point all of the work, as furnished by Marine Iron Works, was transported to Athabasca Landing on sleds through deep snow. Some of the illustrations give a fair conception of what was encountered.

Fig. 1 shows these sleds loaded with the boiler and other parts of machinery a short ways from where it was unloaded from the car. The material was conveyed in this manner over what is known as the plains, beyond which the mountains and timber region are located.

Fig. 2, of the sled partially upset with the boiler, and in a country where the snow is several feet deep, illustrates the difficulties that were encountered and which, without the aid of lifting jacks, etc., for readjusting the loads, would be discouraging to the average man.

The distance which this machinery with the boat frames was hauled, from Edmonton to Athabasca Landing, is approximately 100 miles. At Athabasca Landing, the gentleman who had charge of the transporting and re-erecting of

FIG. 3.—BARGE WITH BOILER, JUST AFTER BEING WRECKED ON THE ROCK AT ONE OF THE RAPIDS.

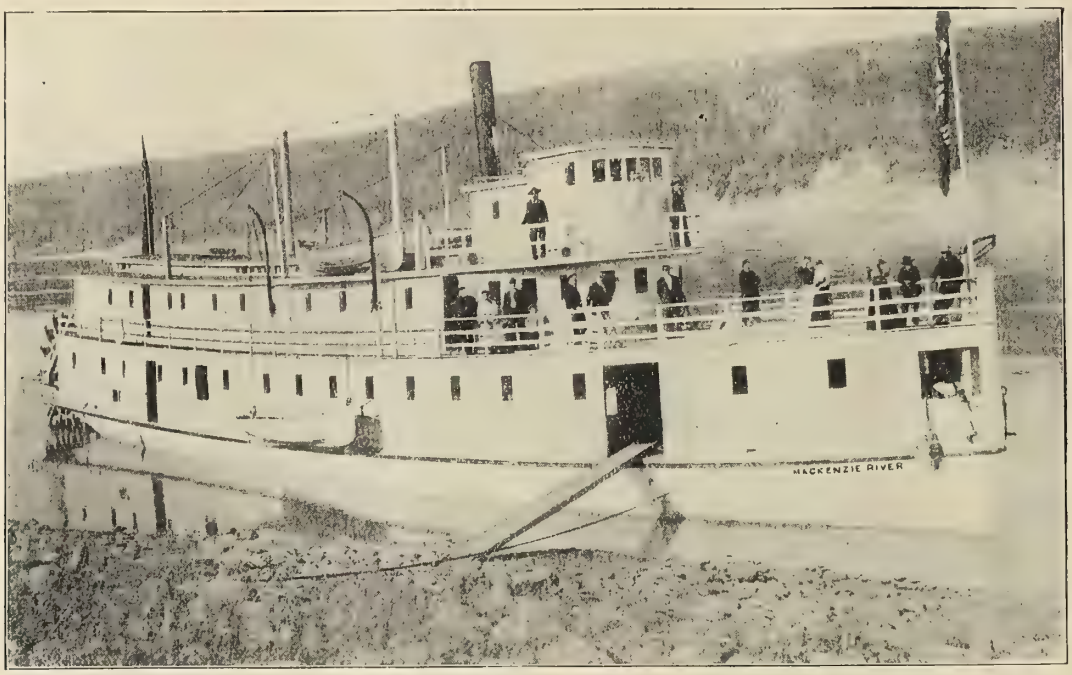


FIG. 4.—THE COMPLETED BOAT WITH THE BOILER AND MACHINERY IN PLACE READY FOR HER INITIAL TRIP.

the boat (Capt. Mills) began the first operation towards preparing the boat and machinery for its initial trip on the water, for here were constructed scows, or barges, on which were loaded the machinery and frames, and they were transported on these barges a distance of 252 miles through the dangerous rapids of the Athabasca River. During this part of the journey one of the scows carrying the boiler struck on the rocks, and Fig. 3 shows this mishap shortly after it had taken place. Driftwood and other material piled up around the boiler inside of twenty-four hours after the mishap, but by the use of lines, pulleys, etc., the boiler was hauled to shore, a new scow constructed, into which the boiler was loaded and delivered at Fort Smith. The principal help that assisted in getting the boiler ashore and loading it onto the new scow or barge consisted of native Indians.

In transporting this material four portages were en-

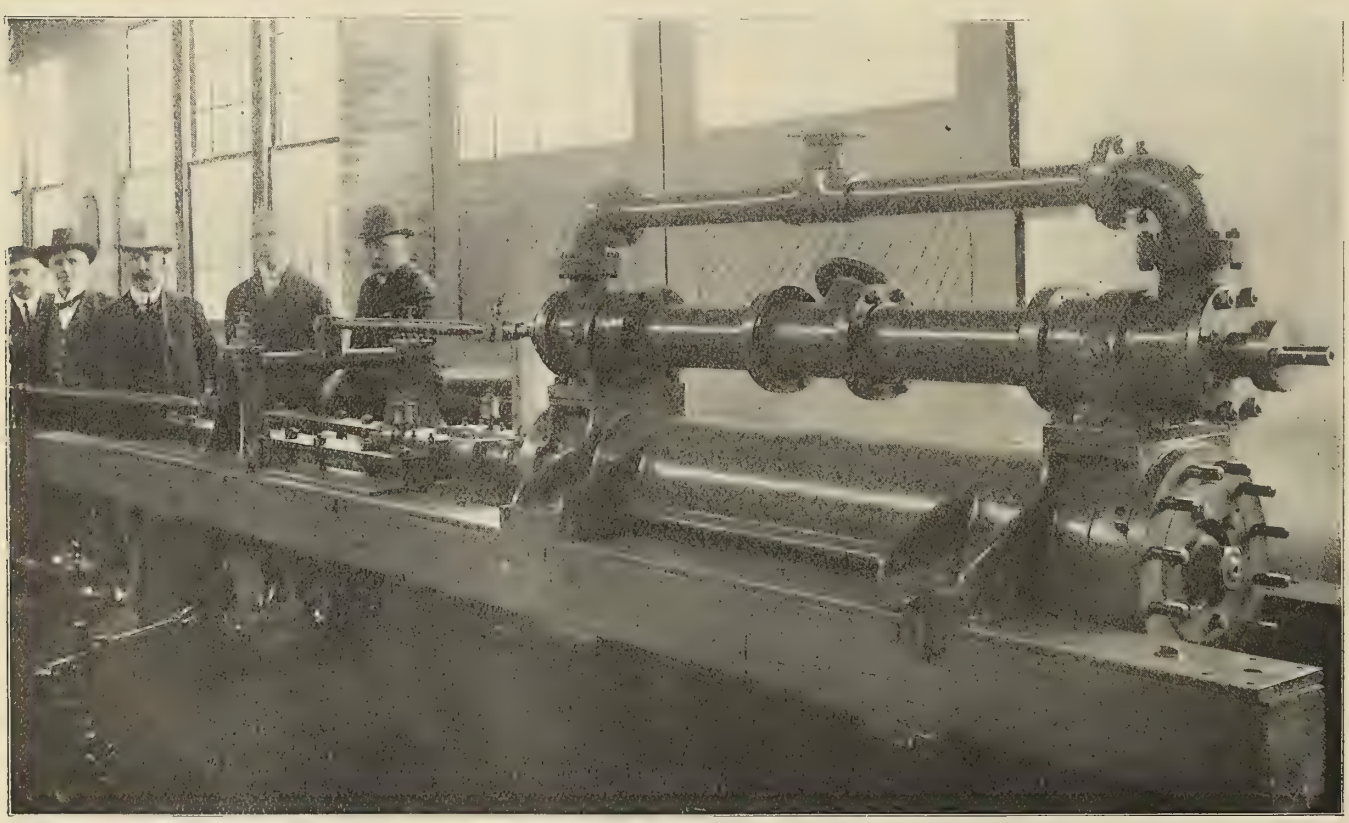


FIG. 5.—ENGINES OF STEAMER MACKENZIE RIVER.

countered, that is, four times during the journey the material was unloaded from the scows, transferred across and around rapids, the scows being transported overland, launched, and the machinery again loaded.

Fig. 4 shows the completed boat shortly after she was put into service for a run on the Mackenzie River and Great Slave Lake, where she has been and is now in very successful operation, proving a credit to the owners as well as the designers and builders.

Taking into consideration the hardships that Capt. Mills met with in transporting the steamer, it seems almost a miracle that the actual loss of supplies that accompanied the boat from its original building amounted to only a few kegs of rivets, and which the captain—being a man of resource—replaced by cutting some bars of round iron (which also went with the shipment) into the desired lengths for these rivets.

Fig. 5 shows the engines of the *Mackenzie River* while they were being erected at the shops of the builders, and just previous to the steam test.

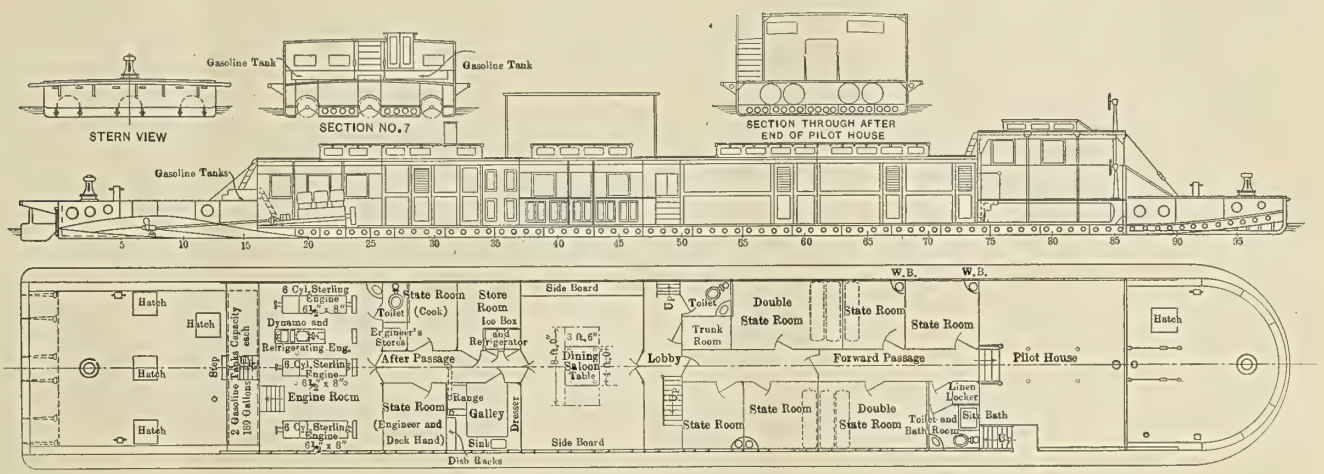
In the preliminary erection of the framework of the boat by the builders the greatest care was used in the manner in which every piece was marked, so that no one, however inexperienced he might be in shipbuilding, could have any difficulty in re-erecting the work with the aid of the clear and complete drawings showing the corresponding numbers that accompanied this boat.

and has commissioned Gielow & Orr, of New York City, to work out the various details of this craft; this firm also is superintending the construction of the vessel. The contracts have been signed, and she is now being built at the Howard Ship Yards Company, Jeffersonville, Ind., and will be ready for her owner's use on or before the 1st of February, 1911.

The principal dimensions of this new craft are: Length over all, 130 feet; length on load waterline, 126 feet, and beam, extreme, 20 feet 8 inches. The most remarkable feature is her extremely light draft, which will be only 12½ inches when fully loaded and with all her equipment on board.

The hull of the boat will be constructed of mild steel of the very best quality, and her scantlings, while light, are in no sense extremely so. In fact, her plating ranges from 3/16 inch to ¼ inch in thickness. The hull is sub-divided into a number of compartments by means of steel bulkheads, so that, even with several compartments filled with water, the vessel will still remain afloat.

Great structural strength is obtained by a system of cellular construction of her bottom, which makes the vessel exceedingly rigid and able to withstand the various buckling and twisting stresses to which she may be subjected in case of grounding. Although not intended for outside or sea work, great longitudinal strength is obtained by carrying up the framing of the hull to the upper deck, and by means of steel deck beams, stringers, plates and diagonal bracing.



DETAILS OF A TRIPLE-SCREW, SHALLOW-DRAFT TUNNEL YACHT.

A SHALLOW DRAFT YACHT.

The many bayous and connecting waters of the lower Mississippi River and many of its smaller and shoaler tributaries are a new and almost unknown field in the yachting world, and the conditions surrounding the navigation of these waters require a craft differing very materially from the conventional yacht found in Northern and Eastern waters.

Some of the rivers of the West and Southwest have been known to shift their channel several hundred yards in one night, so that a boat comfortably anchored at night may find itself high and dry and several hundred feet from the water's edge before morning, requiring skids and rollers to bring her back to her native element.

These conditions, logically, demand a vessel of exceedingly light draft, combined with great structural strength, so as to be able to navigate in very shoal water, as well as to be able to withstand the heavy stresses when running aground or being left aground by a rapidly falling stream.

A Western yachtsman, who has had some experience in these comparatively unknown waters, has decided to have built for him a vessel especially adapted to meet these requirements,

The decks are constructed of five-ply white wood veneer, 5/8 inch in thickness, each in five layers, three running fore and aft and two athwartships, glued together with a special glue capable of withstanding moisture indefinitely. These decks are painted on both sides, and are covered with canvas, which is also painted. The stateroom bulkheads are all constructed of similar material, and all the doors of lightest possible design, with "Louvre" panels in their upper halves.

The bow is of the spoon type, semi-circular at the deck line; and along each side, extending all around the vessel, is a guard and walking platform of perforated steel plating, all properly sponsoned and braced, 18 inches in width.

The pilot-house commences 17 feet aft from the forward end of the vessel, and is 15 feet in length fore and aft, extending the full width of the vessel. This will be used as a social hall and smoking room, and there will be a steering gear, arranged to operate from the inside of the pilot-house, as well as from the bridge above.

For a distance of 30 feet aft of the pilot-house the space will be occupied by two double and four single staterooms and two bath and toilet rooms. Aft of this will be a lobby or athwartship passage, 4 feet fore and aft, with a gangway outboard,

and a stairway leading to the deck above. Aft of this will be a dining room, 12 feet 6 inches in length, extending full width of the vessel, fitted with dining table, buffets, sideboards, china closets, etc. Abaft of the dining room will be a galley on the starboard side and a store room, pantry and refrigerator on the port side. Aft of this, on the port side, will be a stateroom for the cook and steward, and on the starboard side a stateroom for the engineers. Next comes the engine room, 12 feet 6 inches in length, and abaft of this the after-deck, 31 feet long, stiffened and braced to be able to carry an automobile and other heavy loads.

In addition to the windows in the sides of the cabin skylights are provided, so as to insure the most perfect ventilation possible. The interior woodwork will be finished in white enamel throughout, excepting the bureaus and other furniture, which will be of hardwood, finished bright. Brass bedsteads will be used in all the staterooms; and the plumbing system provides for running water throughout the vessel.

The propelling machinery will consist of three 60-horsepower, heavy-duty Sterling engines, which will be capable of driving the vessel at a speed of at least 12 miles per hour. On account of the light draft required, the propellers driven by these engines will be operated in tunnels, so that the wheels will be fully protected from submerged logs, or in case of the vessel grounding. The gasoline will be carried in cylindrical steel tanks, especially enclosed in watertight compartments, and these tanks will have a capacity of 1,500 gallons, which will give a cruising radius of over 1,500 miles at normal speed.

The yacht will be equipped with an electric light plant and storage batteries, and will also have an independent ice machine and refrigerating plant, thus supplying ample cold storage for carrying perishable provisions on extended cruises. Power capstans are provided at each end for handling lines and for use in pulling the vessel off in case of grounding. The usual boats will be provided.

Throughout the yacht will be furnished and fitted in a tasteful and comfortable manner, and as she is so much of a departure from the conventional her performance will be watched with more than usual interest.

A PROPOSED DESIGN FOR A STERN-WHEEL RIVER STEAMER.

The illustration shows the design for a large Missouri River steamboat, as worked out by James Rees & Sons Company, Pittsburg, Pa., from the ideas of Captain John Todd, one of the oldest and best navigators and builders of steamboats on the Missouri River. The most important feature of this design, as shown at a glance, is the use of two independent wheels. The first twin stern-wheel steamboats were built in Pittsburg in 1852. During the next few years six were built with this arrangement of wheels. They were the *Challenge* in 1854, the *Aunt Lettie, North Star, William Baird, Alma* and *Adriatic* in 1855. The steamer *I. S. Pringle* also had four engines with two separate wheels astern. Since these boats were built, however, independent stern wheels have not been used on river boats. The design shown herewith of the steamer *John Todd* is, therefore, the first attempt to utilize this method of propulsion in a modern river boat. As shown in the drawings, the starboard wheel is operated by a cross compound and the port wheel by high-pressure engines with boilers in two independent batteries connecting to one main steam pipe under control in the center. The boat has four balanced rudders and steam steering apparatus

The designers are of the opinion that a boat of this kind is the very best type for the quick transportation of freight on the western rivers of America. It is expected that she would be able to navigate any part of the river where a very much smaller boat could go, provided there was sufficient depth of channel, since the independent wheels give exceptional maneuvering power. By adding to the depth of hold the capacity of the boat can be increased from 2,000 to 3,000 tons.

The principal dimensions of the *John Todd* are as follows: Length from stem to after transom, 275 feet; beam, molded, 66 feet; depth of hold, molded, 6 feet; sheer forward, 6 feet 6 inches; aft, 8 inches.

The side and floor frames are 3 inches by 4 inches by 8.5-pound angles forward and 3 inches by 4 inches by 7.2-pound angles aft, spaced 18 inches centers. The deck beams are the same size angles as the forward frames and are secured to the frames by gusset plates, 18 inches by 5/16-inch thick. There are ten floor stringers of 3 inches by 3 inches by 8.4-pound Z-bars, five on each side of the center longitudinal bulkhead, secured and riveted to the floor frames by angle iron clips. There are two rows of stanchions in the hold, 2½ inches by 2½ inches by 5-pound Z-bars spaced every 6 feet to support a heavy deck load. On each side of the hull there is a Z-bar stringer, 3 inches by 3 inches by 8.4 pounds.

The plating is of the best flange open-hearth steel from 55,000 to 65,000 pounds tensile strength. The bow plating and knuckle forward where exposed to wear is 15.3 pounds to the foot; the bottom plating, 12.75 pounds; the sides, 10.2 pounds, and the after stern rake, 7.65 pounds.

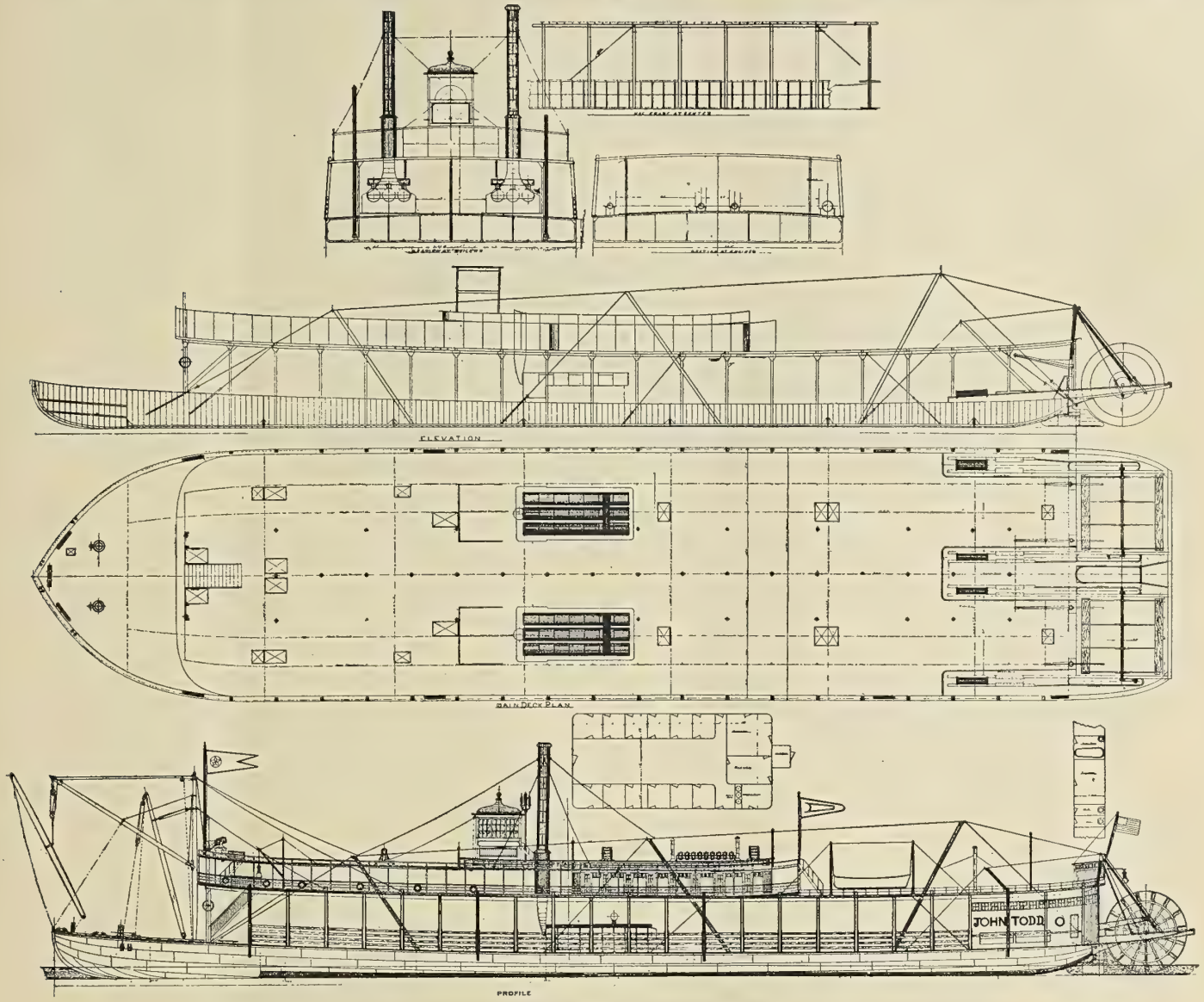
The hull is divided by three fore-and-aft bulkheads, the center bulkhead being of 10-pound plate and the wing bulkheads of 7.65-pound plate, stiffened with 2½ by 2½ by 4-inch angles, spaced every 3 feet and made watertight by Rees' patent steel flanged intercostal. There are also seven transverse bulkheads of 7.65-pound plate, stiffened every 3 feet by angle iron stanchions. The hull is, therefore, divided into 29 watertight compartments. Under the boilers and under the engine beams there is a ¼-inch steel deck and also a 3-inch by ¼-inch plate extends from the stem to the main transom and is secured to the center and transverse bulkheads and deck beams. The remainder of the deck is of 2-inch white pine.

There are four fantails, one on each side and two in the center formed of angle iron and corrugated or checkered plates, extending from the transom to the after-end of the engine beams and secured to the engine beams and jockey beams by plates and gussets. There are four balanced rudders.

The cabin accommodations, as shown in the illustration, are of the regular Missouri River style, designed to accommodate only the crew and a limited number of passengers.

As previously stated, the wheels can be driven by either high-pressure or cross compound engines. If high-pressure engines are used they will be 16 inches diameter and 7 feet stroke. If cross compound are desired, they will be 16 and 32 inches diameter by 7 feet stroke. Each pair of engines drives independently one of the wheels. The wheels are 22 feet in diameter with buckets 20 feet long and 26 inches wide. Steam is furnished by two separate batteries of three boilers each. Locomotive boilers can be substituted if desired.

It is estimated that this boat will have a displacement of 2,500 tons net when loaded to a depth of 8 feet at the stem and 3 feet 6 inches at the stern, or 36 tons to the inch of draft for the first 12 inches, and to increase the displacement as she gradually comes to her full bearing. The estimated weight of material, fuel, etc., is 636 tons, or on a mean draft of 4 feet, 665 tons net, and at a draft of 8 feet forward and 3 feet aft, 1,872 tons net. By loading the boat deeper at the stern the capacity will be largely increased, but the design has simply been worked out according to Missouri River requirements.



PROPOSED DESIGN FOR STEAMER JOHN TODD.

Stern Wheel Steamer Endeavor for the Congo Mission of the Baptist Missionary Society.

The hull and machinery of the stern-wheel steamer *Endeavor,* built for the Congo Mission of the Baptist Missionary Society, were designed to meet the requirements laid down by the missionaries, and both hull and machinery were inspected during progress of Mr. C. T. Williams, the missionary engineer, who came to England from the Congo for this purpose. The Baptist Missionary Society also had the advantage of the advice and assistance generously afforded them by the late Mr. G. L. Watson, of Glasgow, the celebrated naval architect and yacht designer, and, subsequent to his death, by Mr. J. R. Barnett, his parter and successor.

The contract for the whole of the work was placed by the society with Messrs. Salter Bros., launch builders, of Oxford, and they placed the order for the machinery with Messrs. W. Sisson & Company, Ltd., of Gloucester, and also requested them to work out the hull design as far as the structural arrangements, trussing, etc., were concerned.

The general arrangement of the vessel is clearly shown by the illustrations, and, as usual, the hull is well sub-divided into watertight compartments by longitudinal and transverse bulkheads. It may be mentioned that the trussing is of novel design, the vertical pillars being formed of tapered steel tubes, which secure strength and lightness and constitute ventilating shafts for the various compartments. The main tie-bars are connected by turned steel bolts to steel castings securely attached to the pillars and to the main deck and longitudinal framing of the upper deck, an arrangement which proved to be most satisfactory.

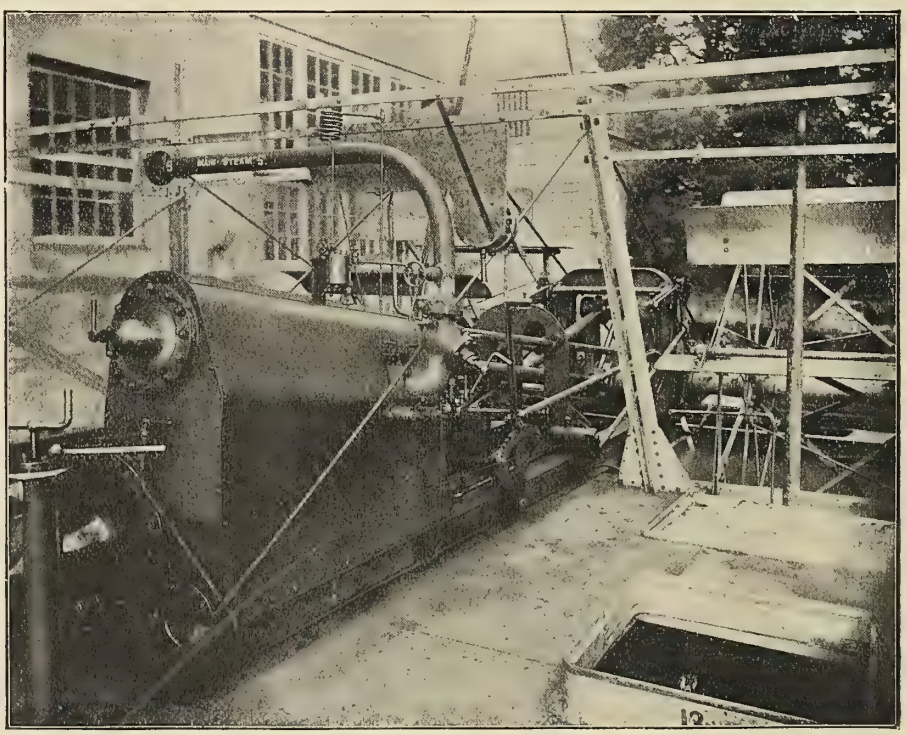
The hull throughout and the main deck are of steel, and the whole of the steel and iron work is galvanized; the upper and shade decks are of teak, the latter being covered with sheet copper. The cabins are of teak and suitably arranged for ventilation for hot climates.

The machinery consists of a pair of W. Sisson & Company's specially designed compound jet condensing engines, arranged on the center line of the boat and having partially superposed cylinders, 11 inches and 22 inches diameter by 48 inches stroke. This is a type of engine which the builders have proved by a good many years' experience to have substantial advantages, such as compactness, lightness and less liability to interference or damage than engines at the sides; also the passage of steam from one cylinder to the other is very direct and the drainage of the cylinders excellent, as they are practically self-draining right through to the exhaust. The crankshafts being coupled only by a drag link are free to take, without injury, a position

BAPTIST MISSIONARY BOAT ENDEAVOR.

out of line with each other if the hull is subjected to any strain or distortion. The channels which form the lower members of the engine framing, in conjunction with the U-shaped steel casting connecting the main bearing brackets (which are also of steel), and the Y-shaped stay from these to the high-pressure cylinder, constitute a stiff and comparatively light framing. The connecting rods are tubular; the valves are of piston type; the valve gear of single-fixed eccentric or Marshall type, and the handling of the engines is thus rendered exceedingly easy. The paddle-wheels are of the feathering type, with a simple and effective form of framing which does not involve the heavy and expensive forgings of the usual form of feathering-wheel framing. The wheel centers are of cast steel.

As before mentioned, jet condensing is employed, there being two double-acting air pumps having automatic suction, and thus without either suction or bucket valves. They are actuated direct by a pair of compound cylinders, whose stroke



ENGINES AND PADDLE WHEELS OF THE ENDEAVOR.

is regulated and motion given to the valve gear by a crankshaft with cranks at right angles, the rods connecting the steam cylinder crossheads to the pump crossheads being double, passing on each side of the crankshaft, the cranks working between them. An automatic expansion shaft governor, formed in the fly-wheel, controls the high-pressure valve and prevents racing under any conditions of load.

The boilers are in duplicate, partly on account of head room, to avoid trespassing on the upper deck room, and partly so as to secure a certain amount of duplication. They are of Sisson type, securing among other advantages uniform length of watertubes, and these are all straight; the water drums are of welded steel tubes pressed into the shape required, thus avoiding any riveted joints except at the two ends. The working pressure is 165 pounds per square inch, and the boilers have the usual accessories, with extra large grates for wood burning, and are fed by duplicate feed pumps of duplex type, or by an automatic restarting injector at pleasure. Suitable valves and connections are arranged so that complete drainage of the watertight compartments can be performed either by the jet condensing pumps above mentioned or by one of the duplex feed pumps. The strainers or rose boxes for all pumps and the injector are arranged at the deck level, with very large copper wire strainers easily accessible for cleaning, and the main injection valves are in duplicate, one at each side. Arrangements are also made for supplying the toilets with water and the bath with either hot or cold water.

The vessel was temporarily erected and riveted up complete with all accessories, the machinery fixed on board, and the trial trip run on the river at Oxford. The whole was then marked for re-erection, dismantled, packed and shipped. Information has been received recently stating that the work has come together with great facility, the re-erection having been quickly performed entirely by native labor, an indication of the excellent workmanship in the hull.

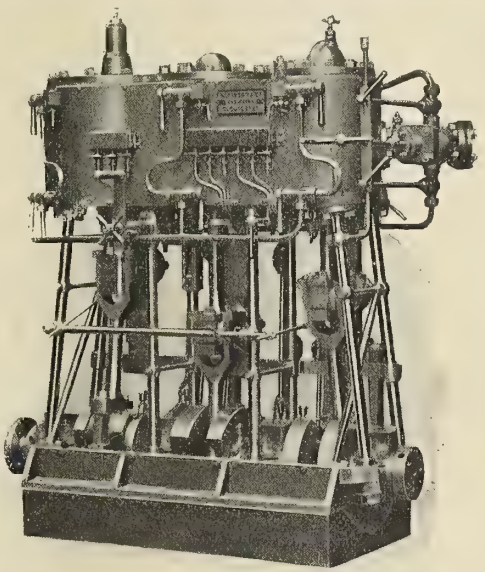
A later report states that the vessel has run over 4,000 miles and proved most satisfactory in respect of speed, carrying capacity, stiffness under all conditions of loading, fuel consumption and ease of handling. The last-named quality is a very valuable one, for navigation on the Congo is beset with many difficulties.

According to a report from Mr. Alfred Stonelake, from Kinshasa, Stanley Pool, the two boilers, each the size of the single (Thornycroft) boiler on an earlier steamer, the *Goodwill,* consume only about the same quantity of fuel (wood) as was used on the *Goodwill.* Instead of two pumps with difficulty feeding the one boiler one pump feeds the two boilers, yet only working about half the time. Instead of the firemen being hard-worked they now have an easy time of it. The engines, too, have received much attention. It is a surprise that engines so small can develop such power and speed. There is a certain vibration of the sponsons to be overcome and then the *Endeavor* will be an ideal steamer. As it is the boat has steamed 2,000 miles without a single worry concerning the engines and boiler.

When the boat was put together temporarily by the builders for her trials the fitting and riveting were carefully and satisfactorily done, and although only about one-half of the rivets were put in there were no leaks during the trials. There was also no difficulty in finally fitting and riveting the vessel in Africa with native labor.

The side paddle-wheel engines are of compound, non-condensing type, having partially superposed cylinders, 9 inches and 13½ inches diameter by 36 inches stroke, with piston valves to both high and low-pressure cylinders. The boilers are of the usual marine return-tube type, 6 feet diameter by 8 feet long, 150 pounds working pressure. The speed of the vessel is 10 miles per hour. The engines were steamed in Messrs. Sisson & Company's shops prior to being sent out to Burma, together with all the steel work and accessories of the hull of the vessel, which was 67 feet 6 inches between perpendiculars by 15 feet molded breadth by 4 feet 3 inches molded depth; draft, 2 feet 6 inches. Complete instructions were supplied to the owners for re-erection and fitting up of the vessel complete in Burma.

An application which has now become comparatively common in connection with a light draft launch is the tunnel arrangement, which enables a screw propeller of suitable diameter to be applied, and thus screw machinery can be utilized for light draft vessels in this manner. When so applied the engines usually run at a high speed, as the propeller diameter is naturally kept as low as practicable so as



TRIPLE-EXPANSION, HIGH-SPEED SISSON MARINE ENGINE.

to reduce the height of tunnel. For such work Sisson's high-speed, double-crank compound and three-crank triple-expansion engines of specially designed light type are very suitable. Either single or twin screw may be arranged for, depending upon the conditions required to be fulfilled, and in such cases the adoption of a watertube type boiler to save weight is advisable.

SHALLOW DRAFT BOATS IN THE PACIFIC NORTHWEST.

The type of shallow draft boats propelled by a stern wheel set athwart the hull, resting on timbers overhanging the transom, has reached a high state of perfection in the Pacific Northwest, and appears extensively on Alaskan rivers. The hulls have very little, if any, dead rise, short rakes astern, and are carried out very full into their forward quarters. This presents the greatest possible bearing surface, and as the weights of materials are kept as light as is consistent with strength and durability, the initial draft is small, rendering them serviceable on streams of shallow depth. Their draft is increased very uniformly per ton of load from light waterline to maximum load line. The less the draft, the less the power required to propel them, a feature which permits them to do some remarkable feats in stemming shallow riffles.

The first craft of this sort built by Joseph Supple, of Portland, Ore., was the steamer *Chester,* a hull 100 feet by 20 feet by 3½ feet, launched in 1895 for service on the upper stretches of the Cowlitz River, a tributary of the Columbia, draining Southwestern Washington. This boat, when launched with

machinery and equipment installed, drew only 5 inches of water. Red cedar was used extensively in her framing, and her timbers were of such small dimensions that many "wise-acres" among steamboat men predicted that she would fall to pieces on her trial trip. She is still in service, however, and bids fair to last several years longer.

FIG. 1.—ONE HUNDRED FOOT STEAMBOAT, WHOSE DRAFT AT LAUNCHING WITH MACHINERY AND EQUIPMENT WAS 5 INCHES.

She has a boiler of locomotive fire-box type and a pair of 6-inch by 24-inch stern-wheel engines. A picture has been taken of her when she was tied to a tree on the bank and a dray had driven into the stream and was receiving freight from her fore deck. The water covered scarcely more than the fetlocks of the horses. She is speedy and easily handled, and her lasting qualities have been a source of wonder to her builder and owners.

Her hull is pliable to a considerable extent, and is held in shape by a simple system of hog chains, which hold up the

FIG. 2.—THE TANONA, AN ENLARGED CHESTER.

boiler, stern and fore deck and hold down the places where the hog posts are stepped. All of her fore-and-aft timbers and planking are rendered continuous by securing the butts together with straps of the same size scantling fastened to each section with carriage bolts. The hull will bend without disturbing any of the joints or casting out the calking materials. In passing over a sand bar carrying less water than her draft, when headed upstream, her fore quarter will rise onto the bar, and the suction of her stern wheel will soon draw out the sand and permit her to slide over. She has been replanked several times, as her bottom wears out from contact with the bars.

Since the discovery of gold on the Yukon there has been a great demand for light-draft boats prepared for shipment knocked-down to a point where they could be reassembled for service. Over twenty boats of this type, varying from 80 feet to 150 feet in length, have been built at the Supple shipyard, and they have all been modeled after the lines of the *Chester,* and have had timbers of proportionate dimensions. As these boats received rough handling and were used on long, difficult runs, they were built a little heavier than the *Chester,* and their draft was increased about 50 percent over hers. It was also found necessary to reinforce the butt straps on the top sides and sheer with plates of No. 10 galvanized steel, which served as a common washer for the strap bolts and added a great deal of strength to these parts.

A novel feature was devised to assist in passing over the swift shoals, consisting of a set of spars which were worked from each side of the fore deck and from each end of the transom. It is hard to describe just how these spars were operated, but the effect was much the same as though a person lying flat on his face would hook himself along with his elbows. The part of the hull bearing heaviest on the bar would bend up, so that perhaps each end would be afloat if the bar were narrow.

These spars are used a great deal, and the hulls have to be replanked every year. In most cases the bottom planks and knuckles are fastened with carriage bolts, and the replanking can be done without damage to the frames, as is the case where spikes are used. In all cases, except one, the top frames have been made of Douglass fir knees, from 1¼-inch to 1¾-inch faces, according to the size of the boat. The one exception was in the steamer *Willie Irving,* which was taken over the Skagway trail and reassembled on Lake Bennett. Her frames were of bent oak, as her owner intended to improvise sleds with them to transport the materials over the White Pass. The wagon road was finished in time to avoid this rough usage of the frames, however, and the first toll collected on this road was on these materials.

The *Irving* was the first steamboat taken down the Yukon through the White Horse Rapids and Miles' Canyon. She was operated two full seasons and part of a third on the run between Dawson and White Horse, and is said to have earned over $250,000 (£51,500) in that short time. As she was only 80 feet by 20 feet in size and made only a dozen trips or so in a season, her earnings are a good gage of the high rates charged for transportation in these pioneer days. She was wrecked in an accident and her remarkable career ended. When shipped, no part or package was over 20 feet long, nor too heavy for two men to carry, except the shaft for her stern wheel, which was a hollow tube weighing about 400 pounds. The boiler was of the watertube type and easily made in sections. The engines were built entirely of cast steel and wrought iron at the factory of the Marine Iron Works in Chicago. She was by far the fastest boat on her run, a fact which, no doubt, added largely to her earning capacity.

Fig. 2 shows the steamer *Tanona*, which was built in 1904 by Joseph Supple from plans made by Capt. Jas. T. Gray, enlarged from measurements taken by him on the steamer *Cluster*. The hull was erected at the Supple shipyard, with deck frame and posts and chains removed. This boat is still on the Fairbanks run, and is claimed to be the swiftest craft of her size in the Yukon district. She is 150 feet by 30 feet.

Some idea of the rapid work performed in reassembling may be had from the fact that the *Tanona* was on her way fully loaded in twenty-one days after her parts reached St. Michaels by steamship. Fig. 2 shows her loaded with 180 tons of freight, and her draft is 38 inches forward and 30 inches aft. Without load she drew 16 inches. Her sparring rig had not been installed when this picture was taken.

In conclusion it should be noted that a successful shallow-draft boat must have a light and timber hull, with as full lines as possible, and all parts must be so constructed that they are pliable, yet strong, and cannot be disarranged by working. While a flat-bottomed boat with side wheels or a propeller boat with tunneled twin screws may give good service for such severe services as have been described in this article, the stern-wheel type seems to give the best results.

THE BLUFF CITY, A TYPICAL LARGE MISSISSIPPI RIVER STEAMER.

THE INDIANA, A TYPICAL OHIO RIVER SIDE-WHEELER.

THE STEAMERS BLUFF CITY AND INDIANA

The steamer *Bluff City*, built expressly to meet the low-water conditions of the Mississippi River, is considered a very able representative of the light-draft stern-wheel type of river boat. She was designed to ply the Mississippi River and all points between St. Louis (Mo.) and New Orleans (La.), a distance of 1,200 miles. Her dimensions are 225 feet length, 42 feet beam, and 6½ feet depth of hold. The hull construction is carried along the lines of strength and light draft.

The power plant consists of a battery of four boilers, 26 feet long, 44 inches in diameter, each containing four 7-inch and two 11-inch flues. The boilers furnish steam for two horizontal high-pressure cylinders, 20 inches in diameter by 8 feet stroke, of the balanced lever type, with California cut-off, turning at 18 revolutions per minute one large stern paddle

wheel, 24 feet diameter, with buckets 27½ feet long and 28 inches wide. Auxiliary engines operate double capstans forward and aft, also freight hoisters and two stages, 50 feet long by 6 feet wide. The stages are used entirely in loading and unloading cargo. Coal for the boilers is carried forward in bunkers, where it can be quickly and easily passed to the furnaces.

From the main deck forward rises the main stairway to the second or boiler deck, on which are the grand saloon or cabin, staterooms, etc. The cabin is painted a pure white and has thirty-two staterooms, accommodating about eighty passengers. It is 156 feet long, the social hall forward measuring 14 feet by 28 feet. The gentlemen's and ladies' saloons, 13½ feet wide, together with the bar, office, barber shop, etc., are on this deck.

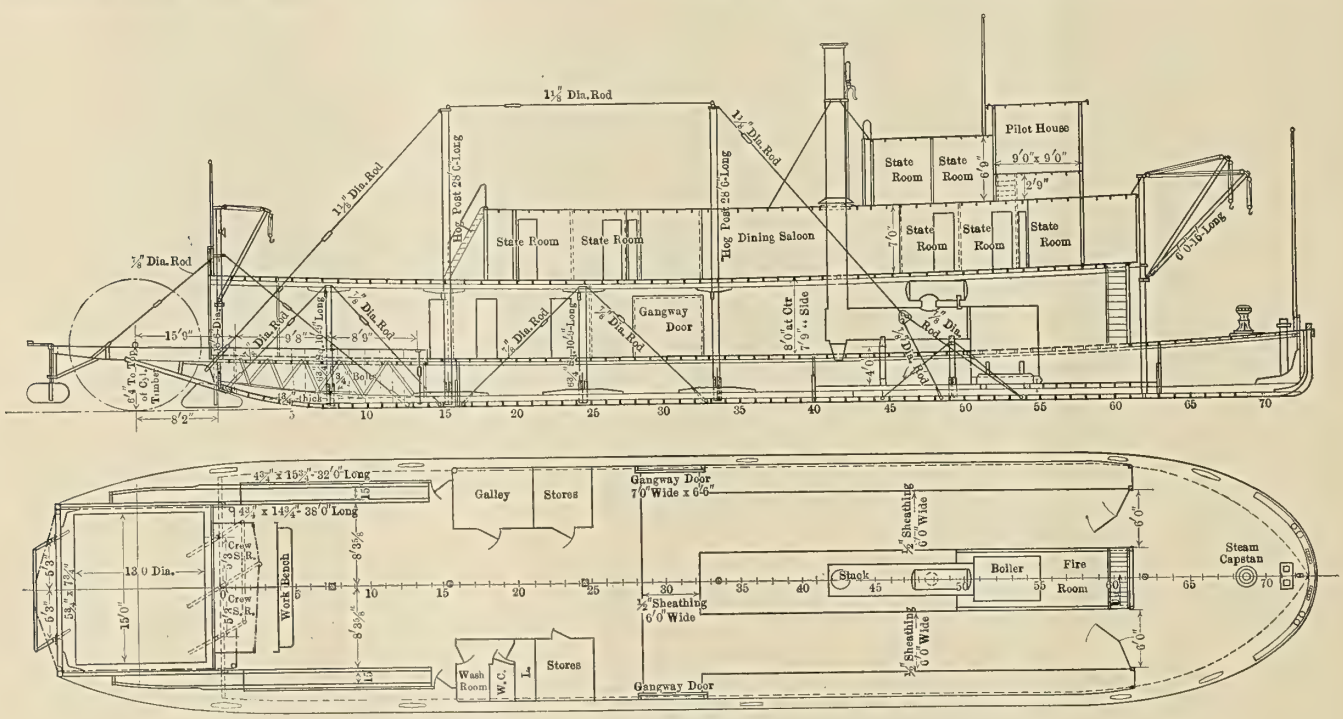
The "texas" is 80 feet long and contains ample and well-furnished quarters for the crew.

the pillow blocks and crossheads are of cast steel. A complete electric plant is situated in the room just aft of the boilers. The hull is of very light construction, but strongly put together, her model, small depth and breadth of beam insuring the necessary light draft. On her trial trip she drew at the point of greatest immersion, at the stern, just 33 inches of water.

Cabin accommodations are provided for about 150 passengers, the rooms being arranged on both sides of a large, long, roomy saloon cabin. All the staterooms are equipped with electric lights, lockers and the usual accommodations.

All the freight that is handled is placed on the main deck, where it is readily accessible and can be moved quickly. It is taken aboard by means of a swinging stage, 40 feet long and 6 feet wide, and is operated by steam.

Both the *Bluff City* and *Indiana* were built by the Howard Ship Yards Company, at Jeffersonville, Ind.



INBOARD PROFILE AND DECK PLAN OF THE ALASKAN RIVER STEAMER TONSINA.

The Ohio River steamer *Indiana* is a typical side wheeler of very light draft. She is one of three passenger and freight packets plying the Ohio River and making trips between Cincinnati, Ohio and Louisville, Ky. Her principal dimensions are as follows: Length, 285 feet; beam, 42 feet; with an extreme width of 80 feet and 6½ feet depth of hold.

The *Indiana* has three decks, the main, cabin or boiler deck, as it is termed, and a hurricane deck. She has a battery of five boilers, 26 feet long, 42 inches in diameter, each of which contains two 15-inch flues. The boiler shell is .28 inch thick; propulsion is by two horizontal high-pressure engines, 25½ inches in diameter by 8-foot stroke, which drive two paddle wheels, 28 feet in diameter, with buckets 15½ feet long and 30 inches wide. Ordinarily the wheels operate at 20 revolutions a minute. The average steam pressure is about 175 pounds. The fuel, coal, is carried on deck in a large bunker, or compartment situated just forward of the boilers. The average consumption of coal, in making a round trip of 300 miles, is about 1,700 bushels. The average speed of the boat is thirteen miles per hour. Her engines are of the high-pressure balance lever type with cut-off, with a cam from main water wheel shaft. The piston rods and wrist pins are of wrought steel.

ALASKAN RIVER BOATS.

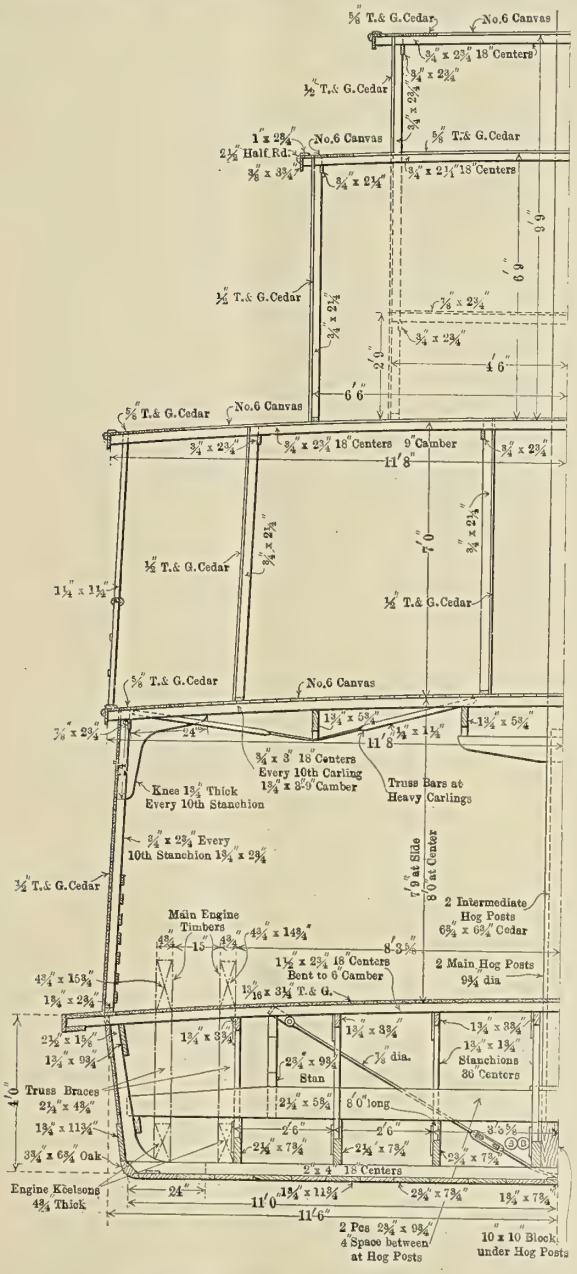
Three stern-wheel river boats, the *Tonsina, Nizina* and *Gulkana,* were built by the Moran Company of Seattle in 1909 for carrying passengers and supplies up the Copper River in Alaska during the construction of the Copper River and Northwestern Railway. They were similar in design and construction, but of different sizes, the *Tonsina* being 120 feet long, the *Nizina* 110 feet long, and the *Gulkana* 80 feet long. They were of very light construction, and, of necessity, of small draft, consequently they had to be shipped "knocked down."

The keel, stem, frames and beams were all erected in the yard, and the garboards, bilge and sheer strakes fitted to them and bolted in position. The entire structure was then carefully marked and taken down for shipment, being permanently erected after arrival at Alaska. As the three boats were all of practically the same proportions, the following description of the *Tonsina* will serve for all three:

The watertight bulkheads were three in number, located one forward of the boiler hatch, one near amidships, and one under the engine room, of vertical cedar ceiling, in two thick-

nesses, with light canvas between and extending to within 24 inches of the deck. A freight house, 102 feet long by 8 feet high, a cabin on the boiler deck, the pilot house and "texas" comprised the superstructure. The freight house, it will be noted, was of ample size. On the main deck were located the crew's quarters, oil lockers, storeroom, toilets and wash room.

The cabin on the boiler deck contained a dining room, galley, locker, eight state rooms, a meat locker and the cook's



MIDSHIP SECTION OF THE TONSINA.

room. The "texas" contained four state rooms; all decks were covered completely with canvas. Life lines of flexible galvanized wire extended from the forward end of the freight house to the stanchions on the fan-tail at each side of the boat.

A reversible steam capstan was fitted on the main deck forward, its principal object being to warp the vessel upstream in a swift current by winding in a line made fast to a tree or stump on land. Leads were also run to the sparring rig aft for lifting the hull clear of a sandbar in case of grounding. Her general equipment was in accordance with the United States Inspection Laws for a boat of her kind and service, and included capstan bars, snatch blocks, warehouse trucks, pike poles, with and without hooks, peavies, handspars, cross-cut saws, pole and ordinary axes, etc. She was provided with a complete outfit of oil-burning lamps in lieu of electric light, and the cabin was heated by an airtight wood-burning stove.

The propelling machinery consisted of one pair of piston-valve stern-wheel engines, 11 inches by 60 inches, with independent cut-off, driven by one locomotive fire-box boiler, with an allowed working pressure of 225 pounds per square inch, and equipped for burning either wood or coal. The auxiliary machinery consisted of two outside-packed feed pumps, one fire and sanitary pump, one boiler-testing pump and one feed-water purifier and heater. Signals from the pilot house to the engine room consisted of the usual gong and jingle bells and speaking tube.

The wheel was 16½ feet diameter outside of the rim irons, with buckets 2 inches by 18 inches by 19 feet 6 inches, mounted on a hollow nickel steel shaft, with wrought iron bedplates, these latter being designed for a considerably higher working pressure than the allowed boiler pressure for extra safety factor. There was also provided one Clinton "Nigger," with 6-inch by 8-inch double engine, with steel spools for the use of wire line.

A Shallow-Draft Houseboat for Southern Waters.

The Merrill-Stevens Company, of Jacksonville, Fla., has recently built for Mr. W. F. Coachman a 48-foot houseboat for service in Southern waters. The general dimensions are: Length, 48 feet; beam, 16 feet, and depth of hull 3 feet. The house is arranged with a cabin or living room forward, with curved glass front. This room also serves as a dining room,

48-FOOT TWIN-SCREW HOUSEBOAT.

the table being round, with drop leaves. The passage way running from this living room to the galley also opens into the two suites, one on either side. Each of these comprises two staterooms and a toilet. The galley has a shipmate range, sink, with running water, and a refrigerator built in the boat. The novel feature of this is that the ice compartment is surrounded by an air passage and is entirely separate from the food. There are also shelves, racks, etc., for dishes convenient for the cook. In fact, many conveniences which are commonly only secured on a large yacht have been included in the equipment of this boat.

Aft of the galley are the engine room and bunks for the crew. There are two Sterling engines of 25 horsepower each. These turn twin screws 19 inches diameter, making about 600 revolutions per minute. From one engine is belted a dynamo, supplying current for the lighting either direct or through a storage battery. The engines are operated either from the engine room or through levers by the pilot either at the wheel in the living room or from the upper deck. This makes it possible for one man to operate the boat if necessary.

The seats on the upper deck are principally covers for the tanks, one gasoline, one fresh water, and one circulating water from the engines to be used in the toilets. The hand fire pump will operate to fill from the surrounding water, the overhead tank, or pump the bilge or wash down decks.

The upper deck, with awning, makes a delightful place to sit in any weather. The awning cover being painted green protects the eye from the sun glare.

The boat was designed for light-draft service and registers 15 tons. She makes about 9 miles an hour, and is quite free from vibration. The exhaust is muffled and leads out astern just above waterline. The whole finish is designed with a view of eliminating polishing. The woodwork is all white, except overhead. The metal work is galvanized wherever possible. The outside wood on the house part is varnished. This is not prominent, as the windows take up nearly all the space. Each window has a drop blind. The doors are blind doors wherever possible. There is free ventilation over each partition between the cabins. The stairs from the living room to the deck above are covered with a hatch when desired. There are electric bells from the galley and engine room to the living room and deck. The whole equipment is designed especially for the comfort of the owner and guests in Southern waters.

TANDEM COMPOUND STEAMBOAT ENGINES.

The illustration shows a 12-inch by 26-inch by 72-inch tandem compound condensing engine as constructed by Gillett & Eaton, Lake City, Minn., for a stern-wheel Government river boat. The engine is fitted with Gillett's balanced valve with variable cut-off for both high and low-pressure cylinders, operated by the Gillett & Eaton independent inside valve drive.

The cylinders are made from first class close-grained cast iron properly machined. The low-pressure cylinder is placed aft and keyed by the aft lug to steel keying plates, which fasten directly to the cylinder timbers. The forward end of the low-pressure cylinder is placed on steel holding-down and leveling plates. The high-pressure cylinder is attached to the low-pressure by a steel connecting bracket, which is cast in one piece with both the low and high-pressure cylinder heads. The high-pressure cylinder is not fastened by lugs, but simply by an auxiliary support on the bottom.

The piston head for the high-pressure cylinder is of the solid type with two snap packing rings. The low-pressure piston head is of the bull ring type constructed in parts, thus arranging for ease in caring for or renewing the rings. The driving spider is shrunk and riveted on. The high-pressure head is made a taper fit and secured with a nut.

The piston rod for the two cylinders is in one piece, made of steel and turned to 4½ inches diameter for the low-pressure and 3 inches for the high-pressure. The after end is threaded to fit into the crosshead.

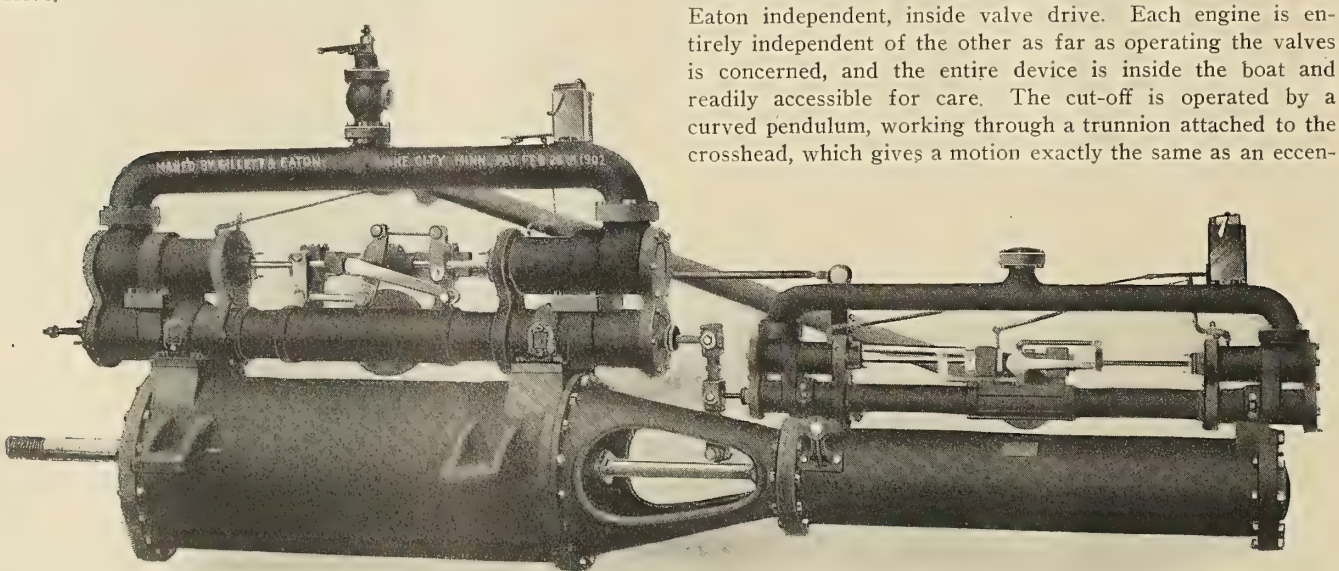
The main body of the crosshead consists of two steel sides, shrunk and riveted to the crosshead pin. This construction admits of the sides being threaded and clamped on to the rod. As already stated, the end of the rod is threaded; thus the adjustment for equalizing the pistons may be easily made, and at the same time a secure fastening is obtained. The crosshead pin is 4¾ inches by 5 inches and of steel. The gibs for the crosshead are of bronze composition, consisting of 77 parts of copper and 8 of tin and 15 of lead. This metal is now the standard bearing metal of the Pennsylvania Railroad, and all brasses for these engines are made of this alloy. The gibs are also babbitted with Hodge's best babbitt.

The engine slides are of cast iron fitted directly to the cylinder beams without separate bed plates.

The pitman ends are of Norway iron forgings fitted with bronze alloy boxes. The ends of the pitman are fitted with extra or king bolts outside of the key and gib.

The pillow blocks are of steel with bottom and quarter brasses. The wheel shaft is of hexagonal forged steel, having a minor diameter of 9½ inches. There are five wheel flanges made of steel, each with 14 arms. These flanges are wedged to the shaft according to the regular Mississippi River approved method. The cranks are of cast steel.

The valve drive is of a patent type, known as the Gillett & Eaton independent, inside valve drive. Each engine is entirely independent of the other as far as operating the valves is concerned, and the entire device is inside the boat and readily accessible for care. The cut-off is operated by a curved pendulum, working through a trunnion attached to the crosshead, which gives a motion exactly the same as an eccen-



GILLETT'S BALANCED VALVE VARIABLE CUT-OFF STEAMBOAT ENGINE.

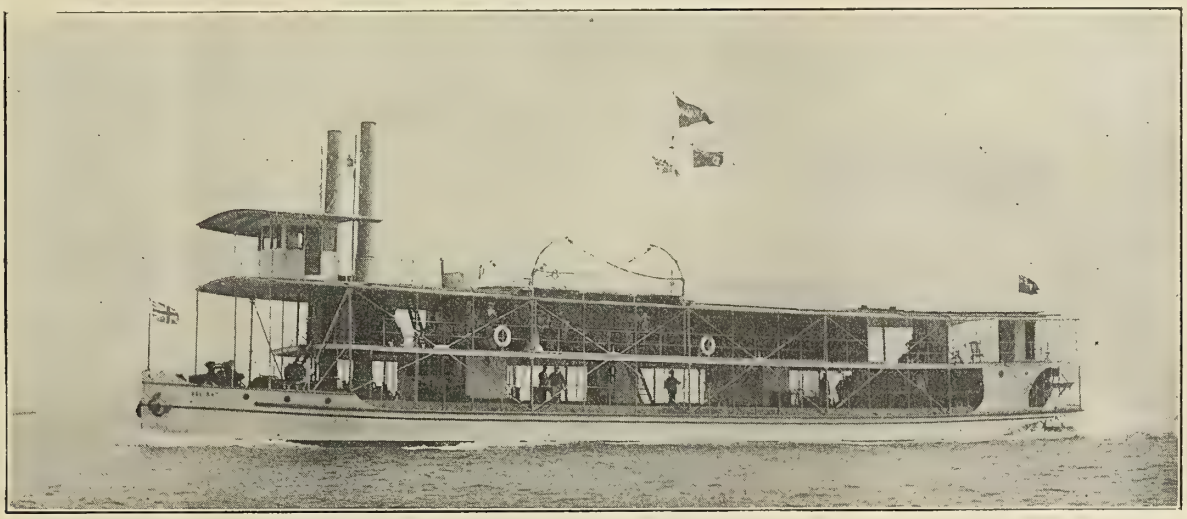
tric set opposite to the crank. The main valve is operated by the oscillating frame, one side of which is a slide over which operates a sliding connection to the center line of the pitman.

In these engines the reverse is operated by a steam-shifting device. The cut-off for both high and low-pressure cylinders is arranged to work together and also their relation to each other is adjustable, so that one may be adjusted independent of the other, thereby permitting a maintenance of the most desirable pressure in the low-pressure cylinder. The ordinary working steam pressure is 200 pounds to the square inch, and the port area throughout is of such size as to permit the engines to work up to 30 revolutions per minute without exceeding a steam or exhaust velocity of 5,000 feet per minute.

with hand rails and ladder at the stern. A steering wheel is fitted on the forward deck. The woodwork throughout is of teak, with watertight steel bulkheads at after end of the forward deck and each end of the motor compartment.

An English Boat in Southern Nigeria.

Messrs. J. Samuel White & Company, Ltd., East Cowes, Isle of Wight, have built a number of shallow draft vessels, the latest of which, embodying all of the best features of design, as worked out by this company, is the *Valiant*, built for service in Southern Nigeria. The designs for this boat were made primarily by Mr. T. Henry Wells, consulting engineer and naval architect of 63 Queen Victoria street, E. C. The details, however, were worked out by Messrs. J. Samuel White & Company. The general arrangement of the boat is evident at a glance from the photograph shown herewith. She is 145 feet long and 27 feet broad, and with a load of 40 tons the draft is 2 feet and the speed 10 miles per hour.



STERN-WHEEL STEAMER VALIANT, FOR SERVICE IN SOUTHERN NIGERIA.

The engines are of the triple-expansion horizontal type of 320 indicated horsepower, and steam is supplied by White-Forster watertube boilers. The suitability of this type of boiler for this service is emphasized by the fact that with native firemen no difficulties have been experienced, and the vessel has been run successfully and economically. There are two paddle wheels, not, however, working independently.

The accommodation consists of eight cabins and officers' salon, with the usual offices, etc., and arrangements for carrying troops.

SEAMLESS STEEL SHALLOW-DRAFT MOTOR LAUNCH.

The method of manufacturing the shallow-draft launches, built by the Seamless Steel Boat Company, Ltd., of Wakefield, is the same as that used for the company's standard type of ship's lifeboat, i. e., each side of the boat is made of one sheet of steel, which is heated in a furnace and then pressed into shape between dies in a large hydraulic press. In shallow-draft launches, however, which are 40 feet by 8 feet by 3 feet 9 inches, the usual type of T-bulb keel bar, to which the sides are riveted, is dispensed with and a flat keel with inside keelsons is substituted, effecting a saving of 3 inches in the draft. The "tunnel" type of stern is adopted to contain the propeller, which would not otherwise be sufficiently immersed and would consequently be inefficient. Inside the tunnel the action of the propeller drives out the air and raises the water until the tunnel is filled. With a gasoline (parafine) motor of 15 brake horsepower the launch attains a speed of 9 miles per hour.

The motor is of the 2-cylinder 4-cycle type, with magneto ignition, free wheel starting gear, water-cooled exhaust silencer, etc., and runs at full load with a consumption of 1½ gallons per hour, the ordinary Russian or American petroleum being used.

A teak cabin is placed in the forward end, with two side seats, which slide out when required to act as sleeping berths, with spring mattresses and reversible cushions. A small lavatory, with wash basin, fresh-water tank, etc., is fitted, together with a water-closet of the ordinary yacht's type, in a separate compartment. The roof of the cabin forms part of an upper deck, which is used as a promenade, being fitted

The result of the first engineering competition of the United States navy, which lasted from July 1, 1909, to June 30, 1910, has been made public, and the *Nebraska* and *Preble* are announced as the trophy winners in the battleship and destroyer classes, respectively. This is the first competition of its kind conducted in the United States navy, and prizes of an aggregate value of $5,000 (£1,030) were awarded to the winners. The saving in coal consumption alone during the year as a result of the economy attendant upon this competition is estimated at about $1,000,000 (£205,000). Large savings have also been made in repairs, in the consumption of lubricating oil and other supplies.

STUDY VANADIUM

Vanadium Crucible Steel Cylinder Casting for Torpedo.

Physical Properties.

Elastic Limit - -	65,000 lbs.
Tensile Strength - -	80,000 lbs.
Elongation in 2" - - -	22%
Reduction of Area - - -	43%

This cylinder was nicked along both sides with cutter, and then flattened under a steam hammer without breaking. The thickness of the walls of this cylinder is 3/16 inch or 33-1/3% less than the thickness of the cast iron cylinders formerly used.

Vanadium is as old as the world.

It is a chemical element refined from the ore. Once more costly than gold, it is now sold by the ton. It is the open secret that explains the fine qualities of the Swedish iron and steel. Every pound of high priced tool steel that comes from Europe contains Vanadium. It is impossible to make the tool steel required by modern conditions without Vanadium. It is also impossible to reach the highest efficiency, life and strength in your castings, forgings, springs, tools and machinery parts without using Vanadium. Therefore study Vanadium, "The Master Alloy."

Be sure to specify the product of the American Vanadium Company, which is the only standard, guaranteed, free from impurities, and correct in every particular.

Illustrated literature free.

American Vanadium Company

318 Frick Building PITTSBURGH, PENNA.

GO AND DO LIKEWISE

Specifications for a new steamship were being decided by the chief engineer of the steamship line and the shipbuilding engineer and during their work the subject of brasses came up.

"I must insist upon Victor Non-Corrosive Silver Metal for the propellers," said the steamship company's engineer. "We have tried all types of bronzes, but this metal is the best because it resists all galvanic action. Zinc strips are necessary with other compositions but none is necessary with the Victor metal. This metal is also very tough and strong, having a tensile strength of 67,000 lbs., and an elastic limit of 45,000 lbs."

"I agree with you there," said the shipbuilding representative, but you will permit us to use our regular bronze for bearings and bushings."

"No," said the engineer, "and I will tell you why." "Several years ago I was looking through the advertisements in a magazine and the following caught my attention:"

STOP

for one moment and estimate the enormous savings in repairs and time you could show in your department by using a bearing metal that would double the present life of your engine bearings.

LOOK

at the wonderful superiority of VICTOR VANADIUM BRONZE over the regular bearing metal used by railroads as shown in comparative test.

LISTEN

to the voice of Opportunity, showing you how the practical elimination of bearing troubles can be attained by the adoption of VICTOR VANADIUM BRONZE.

Comparative Bearing Tests of Victor Vanadium Bronze and other Composition Metals

No. of Bearings	R. P. M.	Load in Lbs.	Time, M.	S.	
1	400	3000	2	15	VICTOR VANADIUM BRONZE
2	400	2000	1	00	Regular Bearing Metal.
3	400	2000	1	15	High Grade Bearing Metal.

Composition No. 2—81% Copper, 9% Tin, 6% Lead, 4% Spelter, Trace of Phosphorous.
Composition No. 3—84% Copper, 12% Tin, 4% Lead, Trace of Phosphorus.

Each of the samples of metals were placed on the machine twice. It will be noted that the time of run checked up exactly in each case. The bearings were placed upon a shaft, 2 15-16" diameter, and the bearing surface in each case was 9 square inches. The speed throughout the test was the same, 400 revolutions per minute, 50% more load was applied to special Victor Vanadium Bronze composition and its time of run was much greater than the other metals. The load applied amounted to 333.33 lbs. per square inch in Special Victor Vanadium Bronze bearing and 222.22 lbs. per square inch in all other bearings.

VANADIUM METALS COMPANY

Frick Building - - - - Pittsburgh, Pa.

"We had such success with Vanadium Steel that I decided to test this Victor Vanadium Bronze Bearing Metal. After some very severe work-outs I adopted this Composition for all my bearings and the results are satisfactory in every respect.

"It is really a marvellous composition metal, embodying not only the essential principles of purity and uniformity of metal and great wearing powers, but also weighs ten per cent. less than any other composition bearing brass of the same dimensions that we have used."

Need We Say More?

VANADIUM METALS COMPANY

Foundry, East Braintree, Mass. **Frick Building, PITTSBURGH, PA.**

TUNNEL BOATS.

The use of screw propellers for the propulsion of shallow-draft vessels has been investigated very thoroughly by Yarrow & Company, Ltd., Scotstoun, Glasgow, and the results of these investigations were embodied in a paper read at the spring meeting of the forty-fourth session of the Institution of Naval Architects by Mr. A. F. Yarrow. The following information is quoted from Mr. Yarrow's paper, and, although perhaps it is familiar to many of our readers, yet it gives a good idea of the design, construction and efficiency of this type of boat, and is well worth keeping in mind in considering the shallow-draft boat problem:

Referring to Fig. 1, which represents a section through a vessel of this type, such as we frequently build, the upper part of the tunnel is considerably above the waterline, thus enabling the diameter of the propeller to be greater than the draft of water. We adopt, for example, in a boat drawing a foot, propellers of 2½ feet diameter, and in a vessel drawing 2 feet, propellers of 4½ feet to 5 feet diameter. When the vessel is at rest the water level inside the tunnel is naturally the same as it is on the outside; but, when the propeller begins to revolve, the air which is enclosed in the upper part of the tunnel is forced out and replaced by solid water. By this means it will be seen that a large propeller, capable of utilizing considerable power, can be used in combination with a shallow draft. There will be an increased resistance to the forward motion of the vessel, due to the action of the screw in reducing the pressure of water at the inclined part of the tunnel forward of the propeller, and this increased resistance is common, more or less, to all screw ships, but it is probably proportionately greater in this class of vessel than in those where the propeller is in the usual position. There is also a loss of efficiency, due to the resistance of the inclined surface of the tunnel aft of the propeller.

The inclined portion of the tunnel aft of the screw should be as nearly horizontal as possible, so as to diminish this resistance; but this would increase the length of the tunnel and involve greater draft, because to augment the capacity of the tunnel below the waterline is just so much loss of displacement, and the water in the tunnel above the waterline is equivalent to just so much load carried when the boat is at rest and the tunnel full. It is, therefore, desirable to reduce the capacity of the tunnel to a minimum, as considerations of draft render it not always practicable to select a favorable inclination at the after part of the tunnel without causing losses, such as those alluded to above, which may be even greater than if a steeper inclination of tunnel be adopted. The tunnel is sealed on all sides, this being necessary, because, when once the air is forced out, it must never be allowed to pass in, or the propeller would not be working in solid water. As regards the forward part and the sides, there is no difficulty in sealing the tunnel satisfactorily, but the extreme after part of the tunnel should be arranged to come two or three inches below the waterline, i. e., sufficiently below the surface to exclude the air. To make the operation clear, I would draw your attention to the model, showing the after part of a launch. This, however, does not demonstrate the system favorably, because the boat is at rest, and the sweeping away of the bubbles of air is not so rapidly effected as when the boat is moving; in fact, in actual full-size examples the action of expelling the air is almost instantaneous. It will be seen that when the motor driving the screw is set in motion the air is driven out of the tunnel, and the propeller then works in solid water.

It has been stated that vessels *Sheikh* and Sultan, which we built in this manner for the Nile, did not tow efficiently, and that the sternwheelers, which we and other firms built for the previous Nile expedition, towed better. That was no doubt perfectly true, and may lead to the impression that vessels built on this plan are not efficient for towing. Such, however, is not the case. As a matter of fact, they are very efficient for towing, provided the propellers are made sufficiently large. With a view to securing the maximum efficiency for speed when not towing, the propellers in all these boats were made of small size. Had the *Sheikh* and *Sultan* been intended for towing, we should, no doubt, have adopted propellers of a diameter at least 50 percent greater than we did. I mention this fact, in passing, to avoid the impression that vessels on this plan do not tow well.

I now come to a departure which we have recently made in the design of these tunnel vessels, and which has added considerably to their efficiency. It will be remembered that the after part of the upper portion of the tunnel, which is inclined downwards towards the stern, is a source of resistance. As already explained, it is compulsory when starting that the after extremity should be below the water in order to prevent air gaining access to the interior of the tunnel. Now, experience has shown that once the boat is under way the after extremity of this tunnel, when full, may be above the surrounding water, because the rush of water out of the tunnel in a sternward direction is such as to prevent the air passing in; in fact, the after part of this tunnel may be 6 or 8 inches higher than the water level without risk from this cause, at the same time improving the result, due to reduced resistance of the inclined surface. It has been shown that the after part of the tunnel should be below the waterline when the vessel is starting light; but if it were fixed in that position it would be unnecessarily low down when the vessel is loaded, thereby involving greater resistance than if the after part of the tunnel terminated at a level sufficient for the loaded boat.

In our more recent vessels of this kind, we have made the upper part of the tunnel, from the propeller to the stern, hinged in such a way that it can be raised and lowered to any desired height, either by machanical means or automatically. Figs. 1 and 2 fully explain the system. Fig. 1 shows the position of the hinged top, or flap, when the boat is light, drawing 11 inches, and Fig 2, when the boat is loaded, drawing 28 inches. It will be seen at a glance that when loaded, if the after extremity of the tunnel were in the same position as it is when light, it would involve a greatly increased resistance, while by raising the top of the tunnel the water has a clear passage open to it to freely pass away in an opposite direction to that in which the vessel is traveling. The gain by the raising and lowering of this flap is illustrated by diagrams in Figs. 3 and 4. When the launch is light, drawing 11 inches with the same power, the speed is increased from 9.2 miles an hour with the flap down to 10 miles an hour with the flap up; and when the draft is 28 inches, loaded with 20 tons, the speed is increased from 6.9 miles an hour with the flap down to 8.25 miles an hour with the flap up, the power at both speeds being the same. As might naturally be expected, the increase of efficiency due to the lifting of the flap is greater when the boat is loaded, the lower speed in both cases being what they would have been if there had been no adjustable flap, clearly showing the advantage of the flap.

Now I propose to describe a set of experiments carried out with a view to test the towing efficiency of this method of propulsion. We built for the Trent Navigation Company a twin-screw tug called the *Little John*. It was 80 feet in length by 14 feet 6 inches beam; minimum draft, with steam up, 22 inches; displacement about 40 tons. Each screw was driven by a single inverted engine, 10 inches in diameter by 10 inches stroke; high-pressure, locomotive boiler. The dimensions of the tug were determined by the size of the locks and the depth of the river.

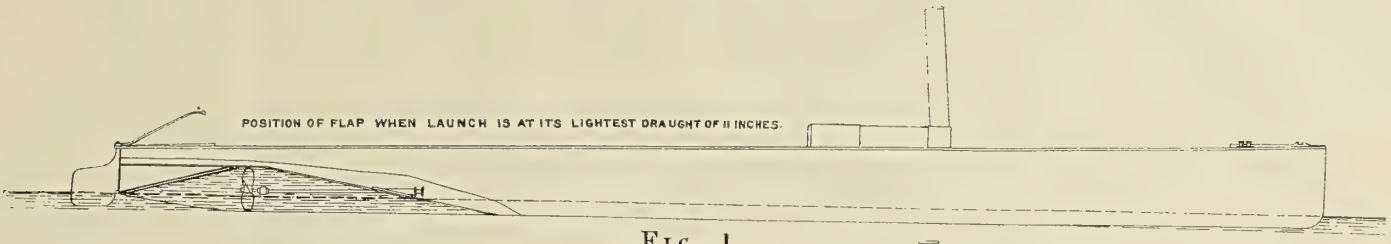


Fig 1

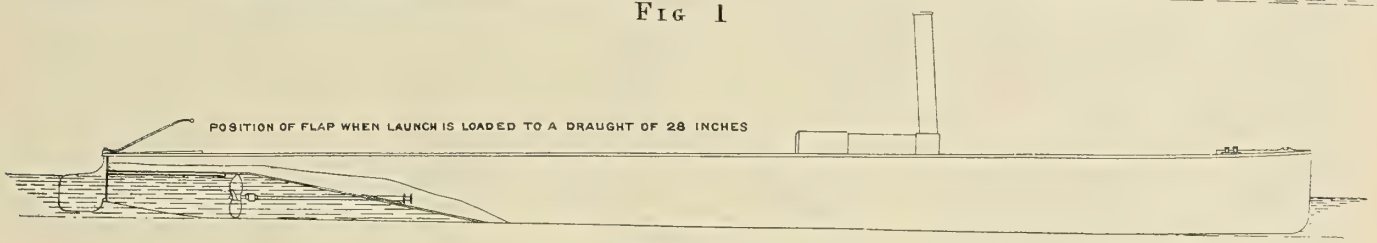


Fig 2.

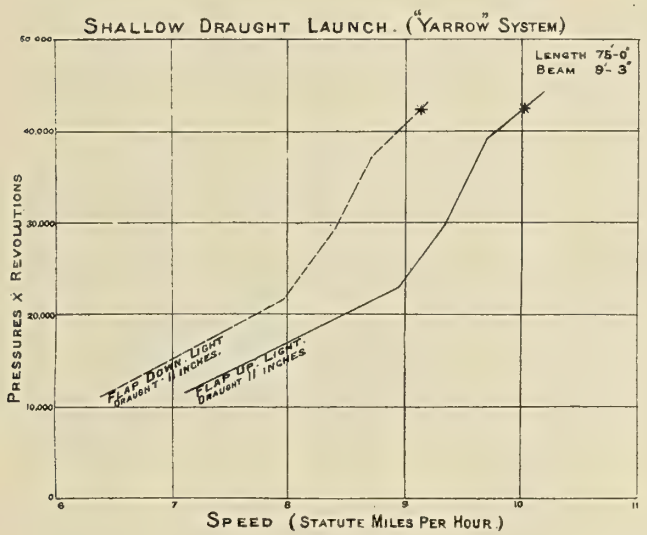
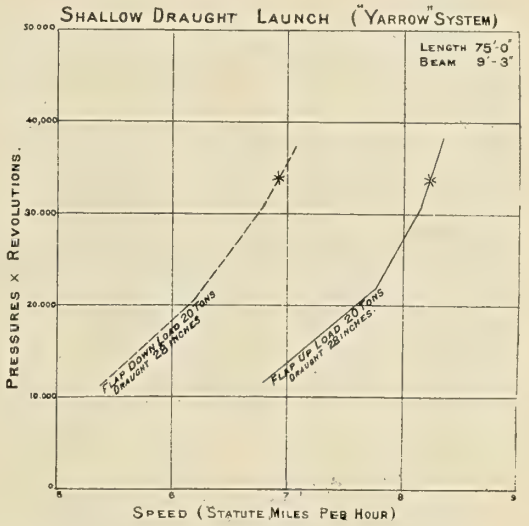

SHALLOW DRAUGHT LAUNCH. ("YARROW" SYSTEM)
LENGTH 75'-0"
BEAM 9'-3"
PRESSURES X REVOLUTIONS
SPEED (STATUTE MILES PER HOUR)
FLAP DOWN LIGHT DRAUGHT 11 INCHES.
FLAP UP LIGHT DRAUGHT 11 INCHES.

Fig 3.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BEAM 9'-3"
PRESSURES X REVOLUTIONS
SPEED (STATUTE MILES PER HOUR)
FLAP DOWN LOAD 20 TONS DRAUGHT 28 INCHES
FLAP UP LOAD 20 TONS DRAUGHT 28 INCHES.

Fig 4

YARROW'S PATENT HINGED FLAP FOR TUNNEL BOATS, AND CURVES SHOWING EFFECT OF THE DEVICE ON SPEED.

Up to the time of our building this boat the Trent Navigation Company had experienced much difficulty in dealing with their traffic. Side-wheelers were found too wide to pass through the locks owing to the paddle-boxes. A twin-screw boat, with propellers in the usual position, proved very inefficient; a stern-wheeler was also tried, and found unsatisfactory. The company therefore determined to make a trial of the tunnel system, and the *Little John* was built. She has been in constant work for several months, and has proved conclusively that this system of propulsion is well adapted for towing purposes, enabling a considerable amount of power to be obtained and efficiently utilized in a small boat with a very limited draft.

Through the kindness of Mr. Rayner, the engineer of the Trent Navigation Company, an excellent comparison was made between our tunnel tug, the *Little John*, and a side-paddle tug, the *Robin Hood*, which the company have for towing on the lower part of the river below the locks, where the river is deeper. This latter vessel had feathering floats, machinery by Penn, and was undoubtedly a good example of this type of vessel, considering the size, draft and power. She had a length over all of 91 feet 6 inches by a beam of 14 feet; breadth over paddle boxes 24 feet, draft 3 feet, displacement about 55 tons; two cylinders, 18 inches diameter by 27 inches stroke, condensing; wheels 9 feet 2 inches over the floats, 3 feet 10½ inches wide; return-tube marine boiler. It will therefore be seen that the *Robin Hood* made a fair comparison with the *Little John*.

In order to test the comparative efficiencies under ordinary working conditions, we towed a number of barges, first with one tug and then with the other, over the same reach of the river, indicating the engines at different speeds, and by means of a dynamometer obtaining the pull on the tow rope. The horsepower ascertained by the pull on the tow rope and the speed through the water would be less than the indicated power of the engines by the loss due to the propellers (whether paddle or screw), the friction in the machinery, and to the power absorbed in driving the tug itself. The barges towed were:

DETAILS OF BARGES USED IN TEST.

Barge.	Cargo.	Weight of Barge.
Severn	57 tons.	20 tons.
Royal Sovereign	50 "	15 "
Victory	50 "	15 "
Congo	Nil	20 "
Crane Boat No. 1	5 "	15 "
Total	162 tons.	85 tons.
Grand total		247 tons.

The comparative results are given in the following table, which shows the horsepower and speed in each case:

TOWING EXPERIMENTS WITH TUGS ROBIN HOOD AND LITTLE JOHN, WITH A VIEW TO TEST THE RELATIVE EFFICIENCY OF THE TWO SYSTEMS OF PROPULSION.

Name of Tug.	I. H. P. of Engines.	Pull on Tow Rope, Pounds.	Horse-power at Rope.	Percentage of Power of Machinery Utilized in Towing.	Speed (Miles) per Hour.
Robin Hood	90.2	2,314	31.6	35.0	5.12
	49.98	1,741	20.0	40.0	4.31
Little John	118.24	2,901	44.1	37.3	5.70
	94.37	2,321	32.3	34.2	5.22
	61.97	1,823	21.3	34.4	4.38

From these experiments and other data it was found that the proportion of the power of the engine utilized in towing is very nearly the same in both cases. The paddle boat is superior to the screw at low speeds and the screw better than the paddle at high speeds. On the average there does not appear to be any appreciable difference. It must, however, be borne in mind that one boat conforms to conditions of draft and dimensions which the other boat does not, the over-all dimensions and draft of the *Little John* enabling her to pass through locks and over shallows which the *Robin Hood* could not.

In considering the question of towing on canals or shallow rivers, it is not unreasonable to assume that the screw working in a tunnel damages the banks to a minimum extent, and in this respect is better than the paddle or even a screw in its usual location; because, with the propeller working in a tunnel, the rush of water being in an inclined direction towards the bottom, rather tends to scour it and to keep open the course, while with paddles the effect would be rather to disturb the banks and to cause the earth that is washed away from the sides to settle in the middle.

NOTES ON SHALLOW-DRAFT STEAMERS.

BY A BRITISH SHIPBUILDER.

Only those who have been abroad and studied the question of shallow-draft rivers can realize the difficulty of transport and the obstacles which have to be overcome by those trading on these rivers and by the naval architects and shipbuilders who design and build shallow-draft vessels, i. e., boats drawing from 12 inches to 4 feet of water.

There are three systems of propulsion, namely, side paddle, stern wheel and screw in tunnel. The latter form of propulsion is the most up-to-date, and under certain conditions results have been obtained which are far superior to those of the side paddle or stern wheeler.

When a vessel is designed to carry cargo, her draft is constantly varying. For instance, a large vessel which G. Rennie & Company, Greenwich, has just constructed, at one time of the year draws 3 feet of water and at another time of the year can draw as much as 5 feet. It is here where the screw in tunnel vessel fitted with Messrs. Yarrow's ingenious hinged flap has a great pull over the side-paddle and stern-wheel type of vessel, for it is quite apparent that in either of these types of vessels the floats at one period would be too much immersed and at another period too little immersed to get the best results.

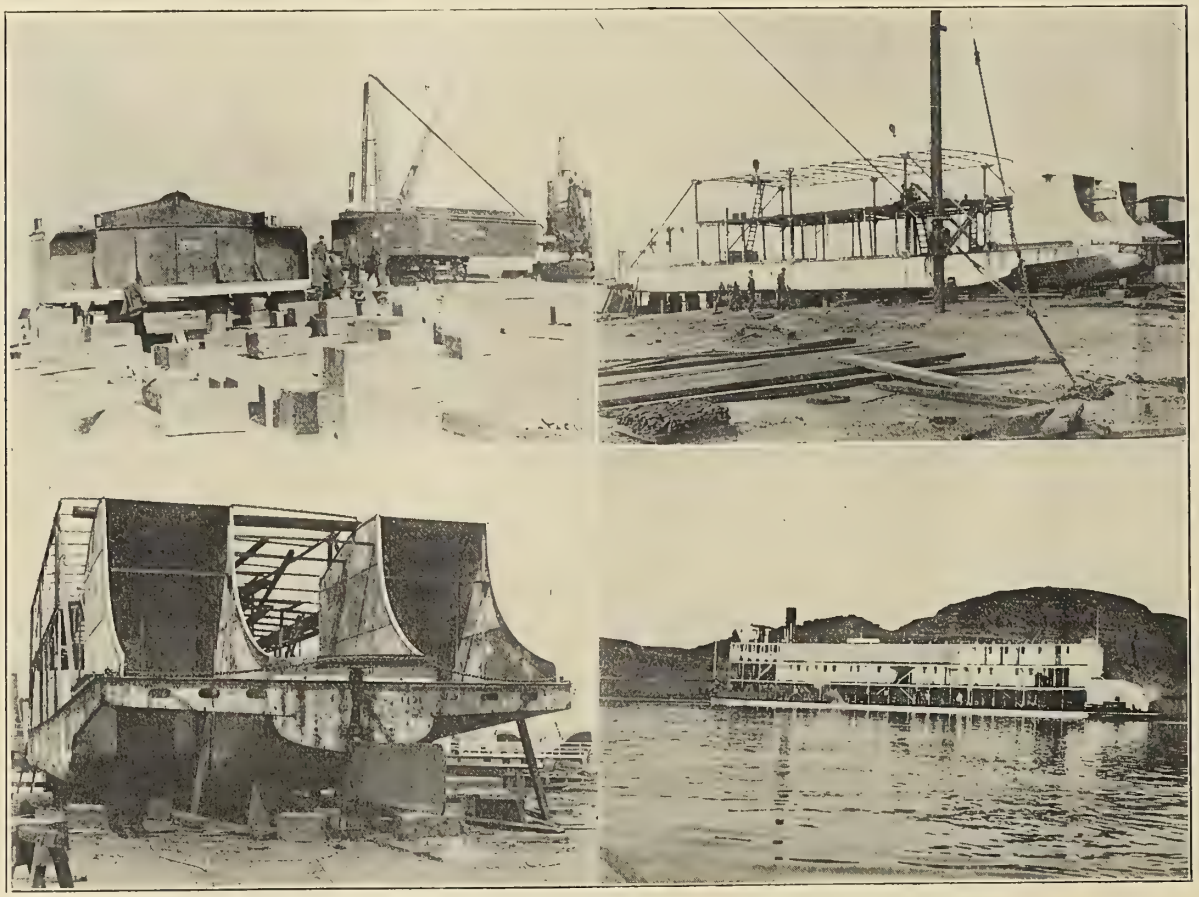


FIG. 1.—LARGE STEEL HULL, STERN-WHEEL RIVER STEAMER IN VARIOUS STAGES OF CONSTRUCTION.

It must not be imagined, however, that all the advantages lay with the screw in tunnel boat. In going astern or in pulling up quickly undoubtedly the paddle wheel or stern wheeler has a considerable advantage. This, of course, is an objection to the screw vessel when trading on a river which is intersected with sand banks and narrow channels. It is here, we think, that the stern wheel has the advantage over the side

LARGE BELGIAN RIVER STEAMER.

wheel, owing to less breadth which this type of vessel takes up in a narrow channel.

On rivers such as the Nile there is a great difference of opinion as to which form of propulsion is best. One large company will have nothing else but side-wheel vessels, and another company will have nothing to do with this class of boat and will insist upon having stern-wheel vessels. In general, when there is sufficient breadth of river, the side wheel seems to be preferable, and there is certainly not so much vibration from this form of propulsion.

Perhaps the greatest disadvantage of the stern-wheel steamer is derived from the fact that the engines and boiler must be at opposite ends of the vessel and thus necessitate the strengthening of the vessel by means of king posts and hogging girders in order to prevent any tendency for the vessel to buckle in the middle.

On the other hand the great advantage of the screw in tunnel over the side and stern-wheel steamer is the saving in weight of machinery. For instance in a vessel recently constructed by G. Rennie & Company there was a saving of 50 tons over the paddle boat of similar dimensions, and the power of the screw boat was nearly double that of the paddle. It will therefore he seen that when there is any question of carrying capacity on a given draft, there are great advantages to be derived from the screw in tunnel vessel.

Fig. 1 shows the sections of a shallow-draft, stern-wheel steamer being erected for shipment at the builders' yard. The view of the completed steamer shows one of the largest stern-wheel passenger steamers that have been built.

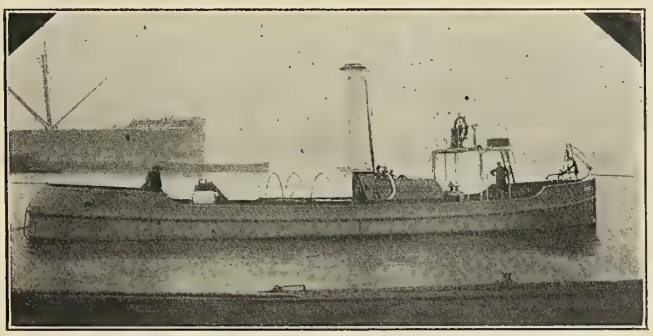


FIG. 2.

Fig. 2 shows a shallow-draft tug, built by G. Rennie & Company for towing purposes only. She is fitted with 200 horsepower engines and has a draft of 2 feet 10 inches aft and 18 inches forward, with 6 tons of coal on board. The speed is 10 knots and the screws work in partial tunnels.

Canada has reached tenth place among the nations in the world's shipping. At the end of the last fiscal year there were recorded in this country 7,768 vessels of 718,533 gross tons.

Belgian River Boats.

Many shallow draft river boats, both of the side-wheel and stern-wheel types, are built in Belgium by the Société Anonyme John Cockerill, Hoboken. While many of these are for service on Belgian rivers, yet large fleets have been built for navigating Russian rivers, including 54 for postal service and passenger and freight traffic on the Volga. Some of the boats in this fleet can accommodate 2,000 passengers and are fitted out with all the modern improvements which tend toward comfort and convenience of the passengers. One of the latest boats of this type is the Kriloff, 280 feet long, 1,000 indicated horsepower and a speed of five miles per hour, which is capable of carrying 19,000 pounds at the full load draft of 4 feet 8 inches.

The stern-wheel boats built by this company are destined largely for the Belgian colonies. Traffic on the Congo and its tributaries is carried out largely by boats of this type. The *Kintanbo* and *Segitini,* built for the Governor of the Belgian colonies, measure 164 feet long, 41 feet beam and 6½ feet depth. They carry 500 tons of cargo at a draft of 5 feet. Propulsion is by means of compound engines of 500 indicated horsepower, which gives them a speed of about 7 or 8 knots.

TOWING STEAMER FOR THE RIVER NILE.

James Rees & Sons Co., Pittsburg, Pa., have built for service on the Nile a shallow draft steamboat of the American Monongahela and Ohio river tow boat type. The principal dimensions are: Length, 141 feet; beam, molded, 26 feet; breadth over all, 26 feet 6 inches; depth of hold from the bottom of the floor to the top of the beam at the lowest place at the gunwale, 4 feet 6 inches. The sheer forward is 36 inches and aft 21 inches.

The hull is of steel with frames of angle bars 2½ by 3 inches by 6.5 pounds, spaced 18 inches apart. The deck beams under the forward deck are 6-inch channels, while the remainder are 2½ inches by 3 inches by 6.5-pound angles cambered 8 inches and spaced about 3 feet.

The hull is divided by three longitudinal bulkheads extending from the first athwartship bulkhead at the bow to the main transom. These bulkheads are of 6-pound plate stiffened by 2¼ inches by 2¼ inches by ¼-inch angles and are secured to the deck beams and deck by angle iron clip stringers from the forward bulkhead to the transom and to the keel and bottom plates by flanged intercostals, making an almost absolute watertight bulkhead. There are also five athwartship bulkheads built of 5.5-pound steel and stiffened with 2¼ inches by 2¼ inches by ¼-inch angles.

On each side of the center bulkhead is a keelson consisting of a 3-inch by 3-inch Z-bar extending from the forward bulkhead to the main transom. There is also one keelson at each bilge built of two Z-bars 4 inches by 6 inches by 15 pounds.

These are designed to support the upper deck stanchions and the main hog chain braces of the boat. There is one row of stanchions on each side of the center bulkhead of 2½ inches by 2½ inches by ¼-inch angles riveted to the deck beams and the Z-bar keelsons. They are spaced 6 feet between centers.

At the bow, where the shell plate is exposed to the severest wear, the plating is 5/16 inch thick. The first keel plate, including the garboards, are also 5/16 inch thick. The remainder of the plating is ¼ inch thick forward and on the knuckle and the balance is 3/16 inch. The sheer strake is 12 inches and 3/16 inch thick.

The deck under the boilers, in the coal bunkers and under the engine beams is of steel plate 3/16 inch thick. The rest of the deck is covered with 2¼-inch white pine, except the capstan bed, which is of steel covered with oak. The engine beams are of steel plate and angle bars of I-beam form. The main beam is 8 inches on the face and so arranged as to be securely riveted to the deck plate and beams and the main and after transoms and formed to receive the main pillow blocks, with steel castings forming the keying blocks and wheel chain brace steps.

There is one main hog chain on each side of the boat, and also one set of wheel chains with long fastenings in the hold forward. The hog chain braces are of gas pipe with cast iron top and foot pieces, except the wheel chain main king post, which is a steel casting.

The boat is steered by three balanced rudders with stocks of pipe and blades of steel supported and stiffened with angle iron. They are arranged to work in concave recesses, built in the stern of the boat and can swing to an angle of 43 degrees starboard or port. The rudders are operated by a steam steering gear, directly attached to the main tiller and controlled by levers in the pilot house. There is also an attachment for steering by hand when necessary.

The main engines are of the cross compound type with lever balanced poppet valves. The high-pressure cylinder is 16 inches diameter and the low-pressure 32 inches diameter, with a stroke of 6 feet. The valve motion on the full stroke rod is driven from a slide on the main connecting rod, and there is a variable cut-off on each engine adjustable while in motion from ⅜ths to full stroke. The motion for the cut-off is taken from the crosshead, thus giving all the cam motion of the engines from the inside, avoiding the danger of a cam attachment on the wheel shaft. The usual reversing arms and levers for operating the valve motion by steam are provided. The piston rods are of nickel steel with metallic packing. The crossheads are of cast steel with brasses adjustable with set screws. The slides are adjustable on cast iron bearings. The pillow blocks are all cast steel with the brasses properly fitted. The connecting rods are of white pine with iron straps welded to the forged pitman jaws with double king bolts in them.

The paddle wheel is 18 feet in diameter and 16 feet 6 inches wide. It is mounted on a shaft of refined new bar iron, 9 inches diameter of journal with 4 wheel centers of cast steel well keyed to the shaft. The wheel arms and circles are of iron and the floats of wood 30 inches wide.

The usual type of feed pump, known as the western river doctor, is fitted, consisting of two hot and two cold water pumps with a heater to heat the water as hot as possible from the exhaust steam of the pumps. There is also an auxiliary steam pump for washing decks, for fire purposes, etc. A hand deck pump is also provided for washing out the boilers by hand.

There are three boilers each 45 inches diameter, 18 feet long, with 44 tubes in each boiler designed for 175 pounds working pressure.

A surface condenser with brass tin tubes and brass heads, designed to take care of steam at a working pressure of 180 pounds and water at a temperature of 85 degrees, is installed with separate air and circulating pumps. A 17½ kilowatt generator with a double Sturtevant engine with switchboard is supplied for lighting the boat and operating a 4,000 candlepower searchlight.

The suction pipes in the hold are copper and brass and the balance of the steam and exhaust piping is of iron and steel. All the couplings and valves are of brass.

The deck machinery includes one large double cast iron barrel capstan with a large main spindle having a countershaft for double purchase with connection by shafts and wheels to the capstan engine with reversible valves and levers to operate the capstan by hand or by steam. There are also two hand capstans located alongside the boilers.

This boat was erected at the builders' works in Pittsburg, then taken apart and shipped to Egypt in packages not over 11 feet wide, 9 feet high or 28 feet long and not exceeding 10 tons in weight. The boat was then re-erected by the owners without any aid from the builders. Soon after she went into service trial trips were made, consisting of a preliminary run from Khartoum to Gebel Aoli and back, and a separate trial over a measured mile while towing three barges. The run from Khartoum to Gebel and back was made at a speed of 9⅓ miles per hour, and the engineer under whose supervision the test was run stated that the main engines worked well, giving plenty of power and proving simple to handle and reverse. During the run the boiler pressure ranged from 140 to 150 pounds. The condenser and feed water heater worked satisfactorily and a vacuum varying between 22.5 and 25 inches was attained. No trouble was experienced in operating the doctor feed pump. It was found that the draft of the boat exceeded 3 feet, with less than 10 tons of coal on board, by about 4 to 6 inches.

On the speed trials over the measured mile, towing three barges, the starboard barge was loaded with stone and drew 4 feet 6 inches; the port barge was loaded with coal and drew 4 feet ½ inch, and the head barge was loaded with stone and drew 4 feet 6½ inches, the average draft of the three being 4 feet ⅓ inch, representing a load of about 817 tons, irrespective of the actual weight of the barges.

On the first trial, the boat made a speed upstream of 5.397 miles per hour and downstream of 7.25 miles per hour, giving a mean speed of 6.313 miles per hour. On a second trial the speed upstream was 5.81 miles per hour and downstream 7.42 miles per hour, giving a mean of 6.615 miles per hour. The steam pressure on these trials did not drop below 155 and was usually between 165 and 170. No coal consumption records were kept on these trials, because results obtained on such short trials are apt to be misleading, but from the statistics of the coal consumption on regular trips to Malakal, the owners state that the boat is very satisfactory on the score of fuel economy. The speed trials showed that a faster craft was built than was anticipated and there proved to be plenty of power to meet all needs.

The Bureau of Navigation reports 376 sail and steam vessels of 95,137 gross tons built in the United States and officially numbered during the quarter ended Sept. 30, 1910. During the corresponding quarter ended Sept. 30, 1909, 347 sail and steam vessels of 48,914 gross tons were built in the United States and officially numbered. There is, therefore, an improvement of nearly 49 percent in this year's showing, as compared with that of last year. Forty-five percent of the total tonnage was comprised of steel steamers built on the Atlantic and Gulf coasts, and 39 percent were steel steamers built on the Great Lakes.

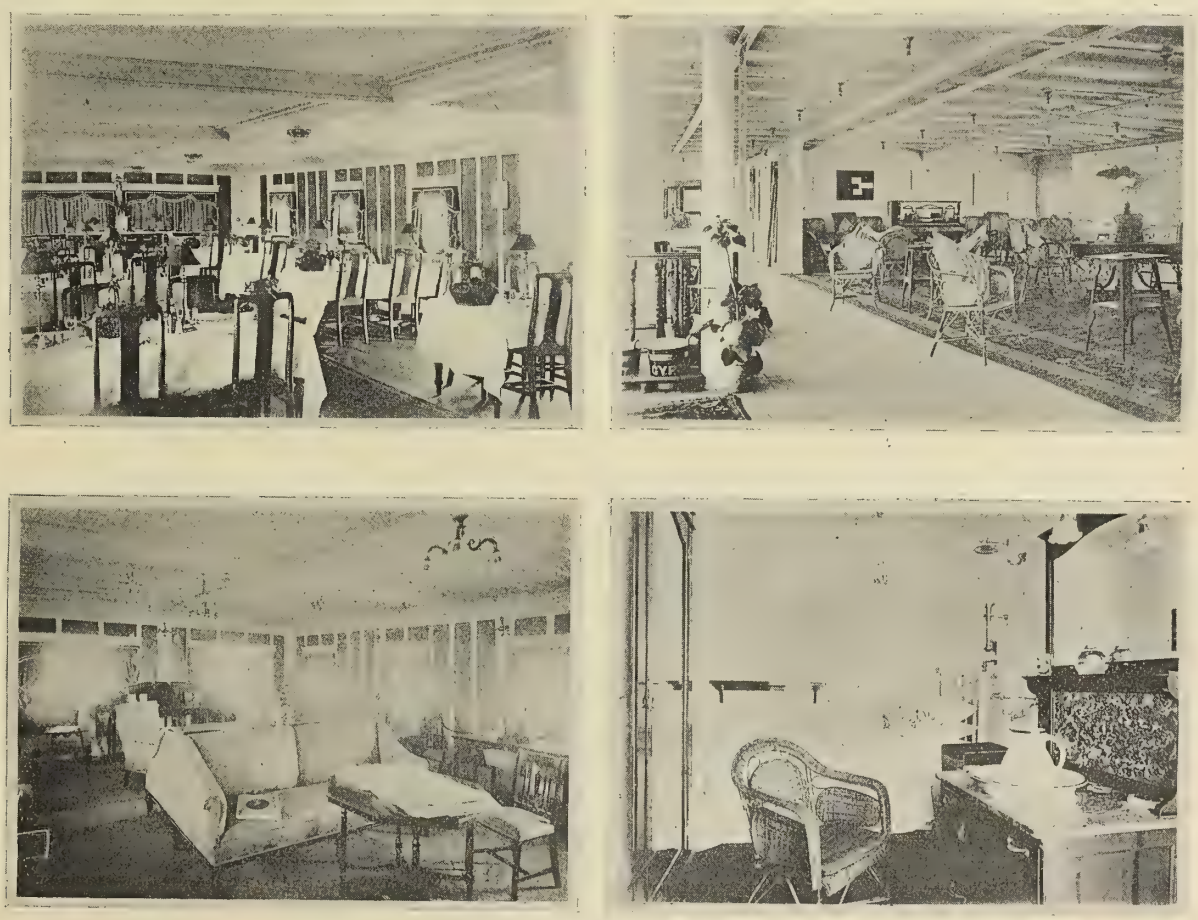
LARGE SIDE-WHEEL PASSENGER STEAMER ON THE RIVER NILE.

The Nile Passenger Steamer Egypt.

Many shallow-draft steamers have been placed in service on the River Nile, but probably the most luxurious is the side-paddle passenger steamer *Egypt*, which was built for Messrs. Thomas Cook & Sons, Ltd., by John I. Thornycroft & Company, Ltd., Southampton. The illustrations show the steamer under service conditions, manned by a native crew, on the River Nile. The interior views give a good idea of the spacious and sumptuous nature of her accommodations. The boat is 230 feet long over all, with a beam of 32 feet. Her depth is 9 feet 6 inches, and the actual draft, fully loaded, only 3 feet 3 inches. She was shipped from the builders' works in loose plates and angles and re-erected at Cairo. The engines are of the diagonal tri-compound, surface-condensing type, capable of giving the boat a speed of over 10 miles per hour.

Shallow-Draft Stern-Wheeler for Mexico.

The Johnson Iron Works, Ltd., New Orleans, La., has under construction a steel-hull stern-wheel steamer, 87 feet between perpendiculars, 24 feet beam, with 4 feet depth of hold amidships. The hull is constructed of galvanized steel plates and has a center line plate and two truss bulkheads. There are also four athwartship bulkheads and steel deck beams, with a yellow pine deck inside the stringer plates. The cabin is to be fitted up for the accommodation of twenty passengers, and will be constructed of mahogany and Spanish cedar. The



INTERIOR VIEWS ON BOARD THE EGYPT.

machinery equipment consists of a pair of tandem compound engines, 7½ inches by 15 inches by 36 inches stroke, fitted with a surface condenser. Steam is supplied by boilers of the fire-box return-tubular type, equipped with two feed pumps. The boat will draw 22 inches of water with 30 tons of freight on board.

The Corona.

Recently the Crown Agents for the Colonies for Northern Nigeria ordered a twin-screw, shallow-draft steamer from Messrs. Forrestt & Company, Ltd., Wyvenhoe, for use as the High Commissioner's yacht. The hull is 160 feet by 30 feet by 5 feet 6 inches, and with stores and a cargo of 38 tons on board it has a draft of 24 inches. The speed is 10½ miles per hour. Comfortable quarters for the High Commissioner are located on the upper deck forward, consisting of a spacious dining room furnished in American oak, adjoining which are the High Commissioner's office and two large sleeping apartments. Accommodation is also provided for the several officers, captain, European engineers and native crew.

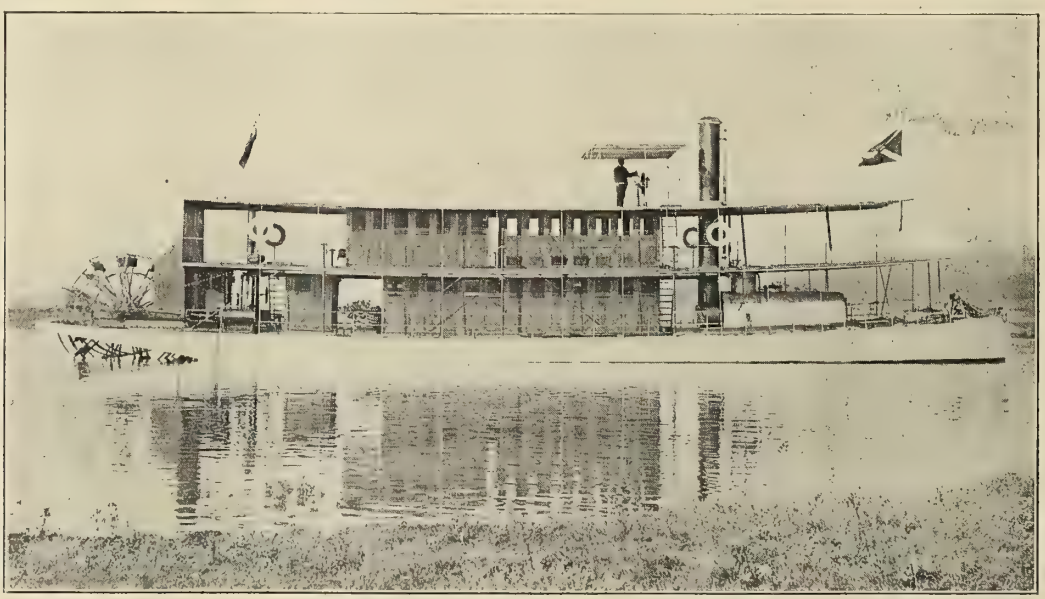
The propelling machinery is of the triple-expansion type, with two watertube Stirling boilers. The designed horse-power is 300. There are also a steam-steering gear, electric light outfit, hot and cold-water baths, refrigerating chamber and plant, and a powerful searchlight.

THE CORONA.

The Millepede.

In the construction of the *Millepede*, a photograph of which is shown herewith, the absence of heavy hog chains and braces should be noted. This, coupled with the comparatively light paddle wheel, marks the principal distinction between many British and American-built stern-wheel river boats. The *Millepede* was built by Forrestt & Company, Ltd., Wyvenhoe, for service on the Zambesi. The hull is 99 feet long by 16 feet broad by 4 feet deep, with a draft of 18 inches. Steam is furnished by a locomotive boiler and propulsion is by means of high-pressure engines aggregating 145 horsepower, giving the boat a speed of 11 miles per hour. The hull is of galvanized steel, built in sections for shipment and the passenger accommodations are in teak deckhouses on the main and upper decks.

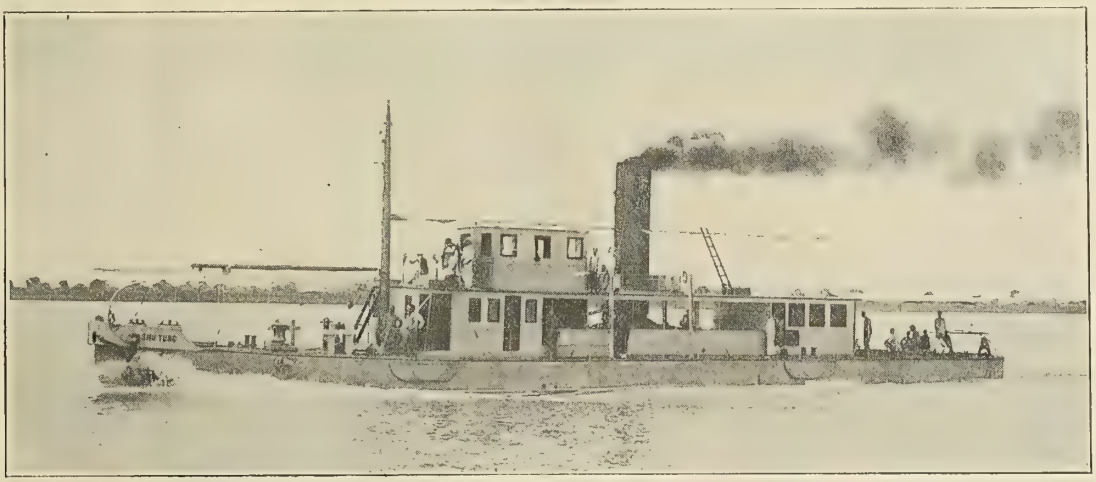
Messrs. Vickers, Sons & Maxim are to build an experimental model towing tank at their works at Barrow-in-Furness.



THE MILLEPEDE.

The Tow Boat Schutung.

The beginning of the development of interior waterways in China has called for shallow-draft passenger and tow boats which are capable of navigating swift rapids, particularly on the upper Yangtse Kiang. This river has been navigated for many years as far as Ichang, which is a thousand miles from the sea, by vessels of 2,000 tons, but until recently navigation beyond Ichang has been entirely carried on by junks, which have taken from four to five weeks for the passage to Chungking, owing to numerous rapids in the river. The navigation of this part of the river by steam was first shown to be feasible by the successful voyages of a number of British gunboats constructed by Messrs. Thornycroft. Recently, however, there has been inaugurated a regular steamboat service by the Szechuan Steam Navigation Company. For this service the steamer *Schutung* has been built by Messrs. John I. Thornycroft & Company, Ltd., Southampton, from designs by and under the supervision of Captain Plant, marine superintendent of the company. At the same time there was constructed a flat, to be towed by the *Schutung*. Both vessels were built in sections and shipped to the East, where they were erected at the Kiangnan Arsenal Dockyard.



TWIN-SCREW TUNNEL TOW-BOAT SCHUTUNG, DESIGNED FOR SERVICE ON THE YANGTSE KIANG RIVER, CHINA.

The *Schutung* is 150 feet long, 15 feet beam, with a depth of 6 feet 6 inches. The propelling machinery consists of two sets of Thornycroft compound surface-condensing engines, aggregating 550 indicated horsepower, which drive twin screws working in tunnels. The speed of the boat on trial was 12 2/3 miles per hour. The flat, which is towed by the steamer, is of the same length and type, but the beam is 16 feet.

Although some of the rapids through which this boat has to operate are exceptionally swift and turbulent, the current in some places amounting to 12 knots and varying greatly with the season of the year, yet under easy current conditions the *Schutung* was able to make the entire journey up the river without resorting to the use of tackle, hawsers, etc., to pull her through the rapids. At the worst point it was necessary to let the boat drift backwards, so that the fires could be cleaned, and then, by careful management in the stoke-hold, full steam pressure was maintained on the engines and the boat successfully negotiated the rapids in spite of the tendency of the propellers to race in the violent swirls of water.

A 100-Foot River Boat.

A 100-foot steel-hull passenger and freight steamer is being constructed by the Dubuque Boat & Boiler Works, Dubuque, Iowa, for service in a river where the depth of water is limited at certain times of the year to 12 inches. The hull is 100 feet 6 inches long, 28 feet wide, with an 8-foot depth of hold. The shell plating is 3/16 inch thick, and the frames are 2 inches by 3 inches by 3/16-inch angle bars. There is one center line plate bulkhead and four additional longitudinal trusses. The main deck beams are channel, 3 inches by 4 inches, and the deck is plated with 8-pound steel.

The machinery plant consists of one tubular boiler, 40 inches in diameter and 10 feet long, with an 18-inch by 18-inch dome. It contains seventy-one 2-inch tubes and is designed for a working pressure of 200 pounds per square inch. The grate area is 12 square feet. There is one pair of 8-inch by 48-inch poppet valve high-pressure engines, with California cut-off. The auxiliaries include a Dubuque boiler feed doctor; a 4-inch by 6-inch type-B Providence capstan, built by the American Ship Windlass Company, Providence, R. I.; and a Carlisle & Finch electric lighting outfit, supplying power for seventy-five incandescent lamps and one 2,000 candle power, 10 ampere searchlight.

Twin-Screw, Shallow-Draft Tug Brinji.

Edward Hayes, of Stony Stratford, has recently built a 60-foot twin-screw tug, for service on the Euphrates River. The boat has a beam of 11 feet and a draft of 3 feet. The engines are each 6 inches by 12 inches by 8 inches stroke, and exhaust into one of the builder's special light-weight condensing plants, which is driven by a small compound surface-condensing engine, 3½ inches by 7 inches by 5 inches. The boilers are of the marine return-tube type, built under Lloyd's Survey for 120 pounds working pressure. The builders have found this pressure to be the best for these vessels, as they are nearly always operated by natives and it is necessary to have all machinery as simple as possible on this account. The designed speed is 12 miles per hour.

A Model German Towing Steamer.

Many types of tugs, steamers, and barges are in use in the vast Elbe River traffic, progress having been made steadily in the direction of larger, higher-powered craft.

Of late much favorable attention has been directed to the tug *Kaiser Wilhelm II*, as the largest and apparently most successful vessel thus far utilized in the business, and a close description of this steamer has been requested by one of the American commissions interested in the development of internal navigation in the United States.

The vessel in question was ordered in 1902 by the Oesterreichische Nordwestdampfschiffahrts-Gesellschaft, whose managers were convinced that tugs of the largest dimensions possible on the Elbe, both as respects size and power, could be operated with the greatest relative economy. The results seem to have exceeded original expectations. The *Kaiser Wilhelm II* is now operated by the Vereinigte Elbe-Schiffahrtsgesellschaften Aktien-Gesellschaft, of Dresden, to which company all ships of the Austrian line have been leased under a special agreement. The vessel plies exclusively between Hamburg and Magdeburg, on the Elbe. It was constructed by the Dresdner Maschinenfabrik und Schiffswerft Uebigau Aktien-Gesellschaft, one of the largest shipyards for river craft in Germany.

The principal measurements of the vessel are as follows:

Length between perpendiculars	236.2 feet
Beam at midship section	29.5 "
Beam over paddle boxes	60.7 "
Depth at sides	9.4 "
Draft in use, with 20 tons coal	3.2 "

The contract required that when the vessel was loaded to 50 percent of its carrying capacity, and with 900 indicated horsepower, it should have a towing power of 4,500 tons, distributed in ten or eleven iron barges, with a stage of water in the river of between 5.2 feet and 6.6 feet, according to the Magdeburg gage. The test run from the railroad bridge at Wittenberg to the Herrenkrug Bridge at Magdeburg (upstream) was to be made in thirty-three to thirty-five hours, and the consumption of coal of good quality of 7,500 calories was not to exceed 2 pounds per indicated horsepower per hour. These conditions were easily fulfilled. During the trial trip the vessel towed eight barges of a cargo of 4,517.7 metric tons of all kinds of merchandise. The trip was made in thirty-one hours instead of thirty-three hours, the average indicated capacity being 950 horsepower, at 39 revolutions per minute. The consumption of coal amounted to 1¾ pounds per indicated horsepower an hour, including steam consumption of the steering engine. The heating power of the coal measured calometrically was 7,730 calories.

Since the ship was put in commission, in 1903, it has been in constant use, except at times when navigation on the Elbe was interrupted by ice or for other reasons. Instead of 4,500 tons, the vessel is almost regularly towing 6,000 tons. In 1905 the vessel was employed 259 days, during which period 10,600 miles were traversed, the towing amounting to 26,650,000 ton miles, in 514 barges.—*Daily Consular and Trade Reports.*

Naval Architects' Meeting.

The eighteenth general meeting of the Society of Naval Architects and Marine Engineers will be held in Assembly Room No. 1, Engineering Societies' Building, 29 West Thirty-ninth Street, New York, Thursday and Friday, November 17 and 18, and will begin at 10 a. m. each day. The society's rooms will be open for the use of all members and the usual conveniences provided.

There will be a banquet in the Waldorf-Astoria (Astor Gallery) at 7 P. M. Friday, November 18, to which all members and their guests are cordially invited. Tickets are $5 each and seats can be engaged in advance or at the meeting.

The council will meet at 3 P. M. Wednesday, November 16. Proposals for membership should be mailed so as to reach the secretary on or before November 16.

The following is a list of the papers expected to be read during the meeting:

Notes on the Armaments of Ships, by Sir William White, honorary member.

Evolution of Screw Propulsion, Part II., by Mr. Charles H. Cramp, vice-president.

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Our Constitutional Shipping Policy and the Compact for its Establishment, by Mr. William W. Bates, member.

INSTALLATION OF A DIESEL MARINE ENGINE ON A LAKE STEAMER.

A case has recently come to our attention where it was found necessary to increase the speed of a certain passenger steamer in order to maintain a profitable service. The steam plant on the boat was not of a modern type, and undoubtedly the performance of the boat could have been improved by substituting a thoroughly modern steam plant. At the same time, however, so much additional power was needed that it was doubtful if a steam plant of the requisite size could have been installed without increasing the draft of the boat and, therefore, increasing its resistance in proportion. The problem was solved by installing a Diesel marine engine of the type built by Sulzer Bros., Winterthur, Switzerland.

The old steam plant was of about 70 indicated horsepower, and its total weight, including boiler, water, smokestack, uptakes, fuel for a 75-mile trip, engine and piping, was 32,400 pounds. The speed of the boat was only about 7½ knots. The Diesel engine installed was of 150 horsepower, and weighed, together with all auxiliaries, fuel tanks and sufficient fuel for a 750-mile trip, 21,500 pounds. Therefore the substitution of the Diesel engine plant showed a saving in weight of approximately 5 tons, which resulted in a noticeable decrease in the draft of the vessel with a consequent considerable diminution of the resistance of the boat in the water. This, in turn, resulted in higher speed for the same output of power. Compared with the former steam plant, the efficiency has been doubled, the supply of liquid fuel carried is sufficient to enable the vessel to travel ten times the distance previously possible, and this at a speed of 11 knots instead of 7½ knots, while a saving in weight of 35 percent has been effected.

The construction of the motor is shown in Fig. 1, while the installation in the steamship is shown in Fig. 2. A complete

description of this type of motor was published in our January, 1910, issue. It will be recalled that the engine has four working cylinders of the single-acting, two-stroke type, besides an air pump for the highly compressed air used for starting, reversing and the injection of the fuel, and also a low-pressure air pump for scavenging the cylinders.

Trial Run	No. 1.	No. 2.	No. 3.
Speed, knots	10.6	10.9	10.1
Distance covered, miles	14.9	14.9	6.1
Time, minutes	73.	71.27	31.6
Fuel consumption, pounds	83.7	92.3	23
Fuel consumption per mile	5.617	6.194	3.77
Revolutions of screw per minute	300	310.9	259
Power of engine, I. H. P.	174	192	114
Fuel consumption per I. H. P.-hour, lbs.	0.395	0.404	0.383
Cost of fuel per mile, pence	1.5	1.67	1.01

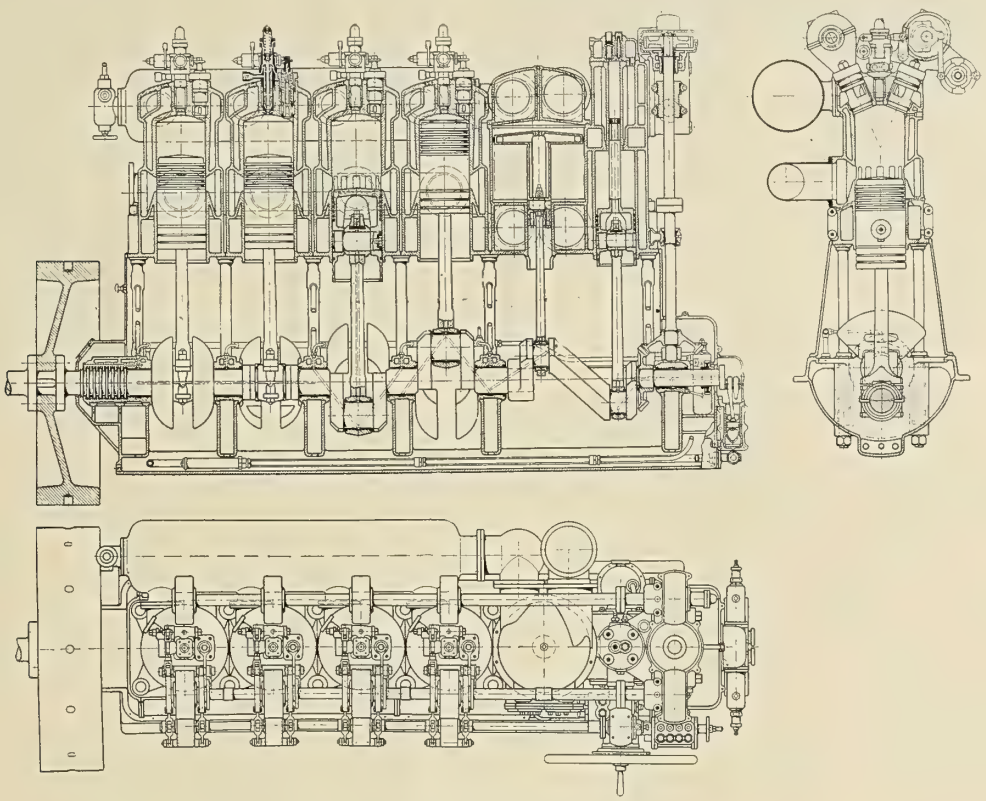

FIG. 1.—SULZER MARINE DIESEL ENGINE.

The trial runs with this vessel, which were carried out by the Zurich Steamship Company, took place on Sept. 30, 1909. The course covered in runs 1 and 2 was exactly 14.9 miles, while course No. 3 measured 6.1 miles. The price of fuel was estimated at about 48s. ($11.50) per ton. Formerly, when steam was used on this boat, the coal consumption, including heating up, was 30 pounds per mile, corresponding to approximately 2¾d. at a speed of 7½ knots. The cost of fuel now amounts to only one-fourth of that required when the boat was propelled by steam, while the speed is increased by 35 percent. Running expenses have also been materially reduced since cleaning, repairs and engine room staff have all been reduced to a minimum. The results of the tests were as follows:

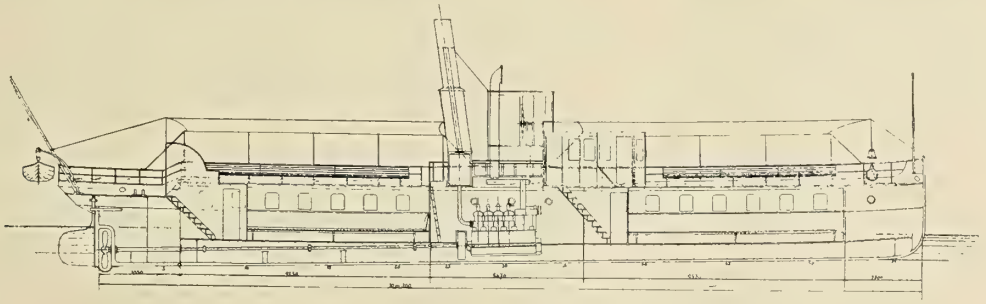

FIG. 2.

Ruling of the Office of the Supervising Inspector-General of the United States Steamboat Inspection Service.

The matter of the authority of local inspectors to specify the distance that must exist between the back and ends of boilers and the bulkheads on towing steamers having been under consideration, it may be stated that the last paragraph of section 29, Rule II, General Rules and Regulations, provides that "*All* boilers shall have a clear space at back and ends. When located in close proximity to wooden bulkheads the space between boiler or boilers and bulkheads shall be not less than two feet; with iron or steel bulkheads, not less than 16 inches."

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Notice to Readers.

In order to present in this issue a complete discussion of shallow-draft river boats, all serial articles as well as the letters from practical engineers have been omitted. The next installment of all continued articles will appear in our December issue.

Shallow-Draft River Boats.

No hard and fast rules can be laid down regarding the design of shallow-draft river boats. The conditions of navigation vary on different rivers and generally a different type of boat is needed to navigate the upper waters of a large river than would be needed on the lower part of the river, where the depth of water is greater and the channel freer. In many navigable rivers there are rapids where the current reaches a speed of 12 miles an hour and over, while in others the water carries so much mud and silt in suspension that old channels are frequently choked up, new bars formed and the regular channel changes its position in an incredibly short time. It is evident that all these various characteristics in the rivers themselves will have some influence on the type of boat to be used and the kind of propulsion which must be adopted to give the most efficient service.

In qualifying the subject of this article by the title Shallow Draft River Steamers, it is intended to confine the discussion to boats operating on rivers where the depth of water does not exceed nine feet and where the draft of the boat may be anything from one to five or six feet. The river steamers operating at tide water on large rivers are not influenced by the same considerations which govern the shallower draft boats which navigate to the head waters of the rivers, and their design presents a very different problem. Confining ourselves, therefore, to the lightest draft vessels, it is noticeable at once that the design of the hull is very similar in a majority of cases. Bluff bows, wide sterns, flat bottoms and vertical sides are the main characteristics of the hulls for shallow draft river boats. The draft is usually greater at the bow than at the stern and, if propulsion is by means of a stern wheel or propellers, the boat is usually designed to maintain a constant draft at the stern to insure constant immersion of either the paddles or propellers, the loading of the boat simply changing the trim and bringing the hull down by the head. By allowing greater draft at the bow than at the stern the boats are found to steer much easier, and in case of grounding only the bow is affected and the vessel can usually be worked off by her own power, or if it is desired to lift her over a narrow bar a form of shears can be employed to force the bow across the bar, and this operation will usually make a sufficient channel so that the remainder of the hull will readily pass over the obstruction. The most important reason for making a hull pivotal about the stern, however, is in order to insure constant immersion of the paddle wheel or propellers, as the case may be. As the hulls are both broad and shallow the principal weights are distributed as widely as possible, and the entire hull is thoroughly braced by systems of hog chains, which supply the lack of structural strength in the hull itself. Steel is now almost universally taking the place of wood as material for hull construction and it is greatly superior for use in tropical waters, where wood quickly deteriorates. Where the bottom plates are made of steel at least ⅛ inch thick, or six pounds to the foot, with composite construction the hull will usually outwear and outlast the best wood hull that could be built.

Propulsion of river steamers may be by one of three methods—the stern-wheel paddle, the side-wheel paddle, or the screw propeller. The means of propulsion to be adopted in any case depends almost entirely upon the nature of the river on which the boat is to operate. All three systems are in successful use, but the stern-wheel boat is at present the predominating type. The stern wheeler is used in preference to the side wheeler because the principal weights in such a boat are so disposed that for equal strength of hull the weight of the material in the stern-wheel boat can be less than in a side-wheel boat of corresponding size. Furthermore, the stern wheeler permits a less overall width, and this

is frequently a factor of considerable importance where the width of channel is limited. The use of screw propellers was not very general until the tunnel form of construction was invented and perfected, so that the screws could be protected from damage in case of grounding or of striking floating timber or rocks. Some of the earlier screw-propelled river boats, unfortunately, were not very successful, and this has caused some prejudice in the minds of the older river men against this type of propulsion. There are so many advantages to be gained by its use, however, that it would seem that future developments in shallow-draft river steamers must lie very largely in this direction. Substituting screw propellers for stern-paddle wheels permits an enormous reduction in the weight of the propellers and shafting; the weight of the engines can also be greatly reduced; and, by using a modern type of compound or triple-expansion engine, the economy of steam consumption can be improved vastly over the performance of the ordinary lever poppet valve type of stern-wheel engine, while by the use of watertube boilers the machinery weights can be still further reduced. The machinery space also can be largely reduced by the use of screw propellers. According to one well-known builder of river steamers, a stern wheeler is a trifle superior to a side wheeler from the point of propelling efficiency, since the wheel is working in or near the top of the wave, which follows very close to the stern of the hull, and this claim is frequently justified in the navigation of rapids, where river boats are put to their hardest test.

Although it is almost impossible to secure reliable data regarding the performance of stern-wheel steam boats of the type used on the Western rivers of the United States, yet they are usually considered to be very wasteful of steam. As a rule the boiler plant is fairly efficient, considering the quality of water which must be handled in the majority of cases, but forcing is resorted to to such an extent that an excessive amount of steam is frequently used by means of jet blowers in the flues for increasing the draft. Where exhaust steam from the engines is used for this purpose the loss is not so noticeable. The performance of the engines, about which so much speculation seems to exist, is undoubtedly poor as compared to modern marine engines used elsewhere. Where simple non-condensing engines are used, high-pressure steam is employed and the exhaust is frequently at high pressure, most of the energy in the exhaust steam being thrown away except what is gained from heating the feed water and increasing the draft in the boilers. Compound condensing engines for stern-wheel boats, while more economical, are not generally favored by river men, since the added weight and complication are serious disadvantages. They are useful principally in large boats.

Improvements in existing types of river craft will undoubtedly be in the direction of increasing the efficiency of the steam plant; increasing the maneuvering power of the boats themselves, and providing more economical means of handling and carrying freight. Increased economy in the steam plant, although perhaps not increased propulsive efficiency, can be gained by the adoption of screw propulsion, which will admit of the use of the most economical type of marine engines and watertube boilers. In the case of stern-wheel steamers, the use of two independent light steel feathering paddle wheels, driven by compound engines of modern design, will undoubtedly be effective in packet steamers, but for tow boats, particularly those of the type used on the Western rivers of America, where the boat is used principally as a rudder for immense fleets of coal barges, aggregating anywhere from twenty to sixty thousand tons in a single tow, it is doubtful if any better form of propulsion can be devised than the old-fashioned, large, heavy stern wheel with wooden buckets, which has proved so effective for this work. In boats where screw propulsion can be adopted, a further increase in efficiency is possible through the use of internal combustion engines, operating on either heavy oil or producer gas. The maneuvering properties of stern-wheel boats can be improved by adopting two independent wheels and by the use of monkey rudders aft of the wheels, as well as the usual rudders forward of the wheel. Improvements in the carrying capacity and means for handling freight on board river boats are already being developed by the construction of steel barges suitable for different classes of freight and the installation of mechanical appliances at terminals for handling the freight.

Terminal Facilities at River Ports.

Adequate terminal facilities at river ports are quite as important for the development of river steamboat traffic as are modern types of carriers or river and harbor improvements. In the report of the United States Commissioner of Corporations on transportation by water in the United States, it is stated that the harbors of the country, as a rule, have by no means developed their frontage to the full capacity, nor have they organized and co-ordinated to the best advantage their commercial and industrial functions. It is further stated that great influence is exercised by railroads over water terminals either through ownership, through indirect control, or through long-term leases of water-front property, and that there is very little effective linking up of the rail and water transportation systems, but, on the contrary, the tendency seems toward division and adverse action, to the great detriment of the transportation needs of the public. Finally, there is a striking lack of co-operation with the Federal Government on the part of localities benefiting by channel improvement. These are conditions which must be given immediate attention if transportation by inland rivers is to be developed to the fullest extent of its possibilities.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

BATTLESHIPS.

	Tons.	Knots.		Sept. 1.	Oct. 1.
Florida	20,000	20¾	Navy Yard, New York.....	74.2	77.4
Utah	20,000	20¾	New York Shipbuilding Co...	85.5	88.0
Arkansas ...	26,000	20½	New York Shipbuilding Co...	43.9	47.8
Wyoming ..	26,000	20½	Wm. Cramp & Sons.....	35.5	38.9

TORPEDO-BOAT DESTROYERS.

Paulding ...	742	29½	Bath Iron Works.....	98.9	100.0
Drayton	742	29½	Bath Iron Works.....	91.7	94.4
Roe	742	29½	Newp't News Shipbuilding Co.	99.3	100.0
Terry	742	29½	Newp't News Shipbuilding Co.	93.5	99.0
Perkins	742	29½	Fore River Shipbuilding Co...	93.8	97.4
Sterrett	742	29½	Fore River Shipbuilding Co...	89.8	90.8
McCall	742	29½	New York Shipbuilding Co...	95.5	95.9
Burrows	742	29½	New York Shipbuilding Co...	92.7	94.9
Warrington..	742	29½	Wm. Cramp & Sons.....	81.4	84.7
Mayrant	742	29½	Wm. Cramp & Sons.....	82.0	83.7
Monaghan ..	742	29½	Newp't News Shipbuilding Co.	31.3	35.6
Trippe	742	29½	Bath Iron Works.....	62.6	68.3
Walke	742	29½	Fore River Shipbuilding Co...	52.8	57.5
Ammen	742	29½	New York Shipbuilding Co...	65.4	72.4
Patterson ...	742	29½	Wm. Cramp & Sons.....	44.6	47.8

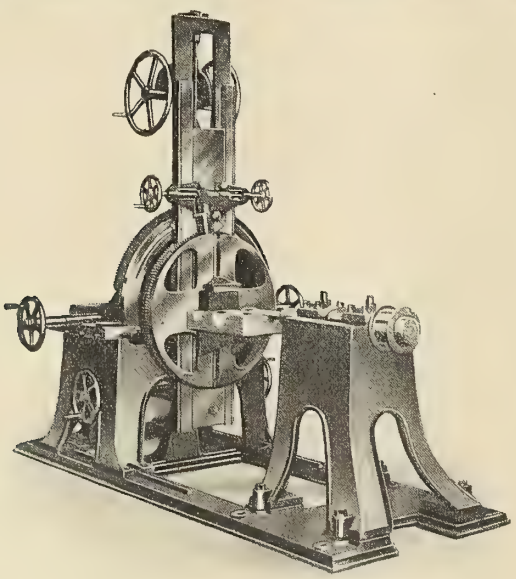
SUBMARINE TORPEDO BOATS.

Salmon	...	..	Fore River Shipbuilding Co...	98.4	100.0
Seal	...	..	Newp't News Shipbuilding Co.	54.4	55.9
Carp	...	..	Union Iron Works.....	62.0	63.0
Barracuda ..	...	..	Union Iron Works.....	62.7	64.8
Pickerel	...	..	The Moran Co.....	58.1	61.1
Skate	...	..	The Moran Co.....	58.1	61.1
Skipjack	...	..	Fore River Shipbuilding Co...	54.0	56.3
Sturgeon ...	...	..	Fore River Shipbuilding Co...	52.5	55.4
Tuna	...	..	Newp't News Shipbuilding Co.	31.8	32.4
Thrasher ...	...	..	Wm. Cramp & Sons.....	10.8	15.7

ENGINEERING SPECIALTIES.

Allan's Patent Comprehensive Woodworker.

Among the newer designs of woodworking machinery that have been introduced in recent years there is an important class constructed chiefly to deal with the difficulties of pattern-making, and for the cutting out of core boxes. As every engineer knows, core boxes are of endless variety, and so



variable that they cannot be touched by ordinary machinery. Designers and inventors have therefore been working out new ideas, with the object of introducing machinery with such flexibility of movement that it could be adapted to deal with all the intricacies and variations that are met with in the pattern shop.

What is claimed to be the simplest and most powerful of these machines is the Patent Comprehensive Woodworker, designed and supplied by R. S. Allan & Company, Gateshead-on-Tyne. This machine, as can be seen from the illustration, has two principal parts mounted on a common foundation or bed-plate. The first important part is the pedestal, bolted to one end of the bed-plate, and which carries a powerful horizontal spindle, which is driven by the pulley on the outer end. The spindle runs in adjustable cone bearings, which, it is claimed, provide absolute steadiness and freedom from vibration. The inner end of the spindle is fitted with suitable arrangement for fixing the cutting tools. Facing the cutters, and raised on V-guides formed on the bed-plate, is a large, powerful stand of simple construction, but with wonderful diversity of movement, which forms the work-carrier. The base is formed with four feet, which rest on the V-guides, and is controlled by a screw and hand-wheel, so that the whole stand can be adjusted to or from the cutters to accommodate large or small work. Mounted on this is a compound slide, by which the work can be advanced to the cutting tools and the depth of cut controlled. This is regulated by the lowest set of hand-wheels on each side of the base.

Mounted on the compound slide is a table formed on the edge, with a quadrant at right angles to the table and with a vertical face towards the spindle. The flange of the quadrant has a set of teeth cut thereon. A long, rectangular member, which carries an adjustable slide, is pivoted on the face of the quadrant, having fixed at the back a bracket with worm and gear, which engages the teeth on the flange and enables the guide or member to be set over at pleasure, either to the right or left of the perpendicular, through an arc of about 60 percent either way, so that work can be readily set at any desired angle by the markings which are cut on the face of the quadrant.

To the slide in this member is bolted a circular work-table or turret, at the edge of which a set of teeth is cut. A worm gear and hand-wheels are carried on the face of the slide above the table, and the worm engages the teeth and so enables the table to be revolved in either direction at will.

All the movements are well arranged and independent, and do not interfere with the setting or working of the machine whatever the position may be, and the machine can be used for all kinds of grooving, half-lapping, trenching, slotting, etc., and for panel moulding, moulding, ships' gratings, ladders and a great variety of general work. Machines of this type are at present being exhibited by the builders at the Brussels International Exhibition, the Japan-British Exhibition, and next month they will be exhibited at the Manchester Engineering and Machinery Exhibition.

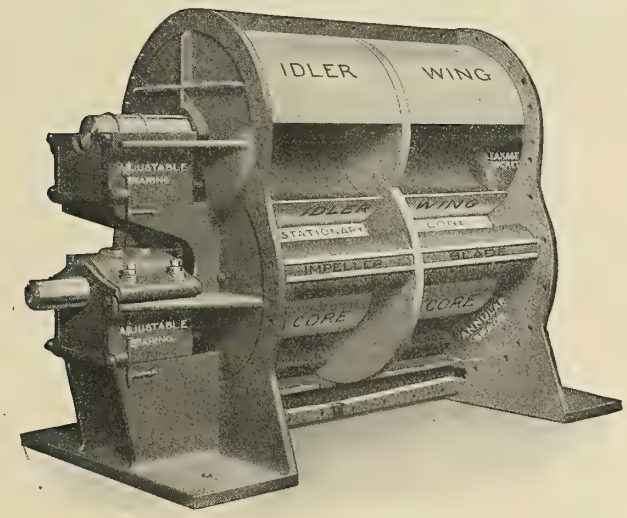
Blower for Fuel Oil Burning.

The high-pressure blower described in this article is being successfully used in marine work for furnishing blast in connection with fuel oil burning, both on shipboard and in navy yards. It is one of the products of the B. F. Sturtevant Company, of Hyde Park, Mass., who claim for it several distinctive features both in design and construction. Although this blower is of the positive type, by its design and operation it is claimed to overcome almost entirely strong pulsations in the discharge and internal contact of the rotors, resulting in a tendency to wear out and difficulty of adjustment. The lack of pulsations in the discharge is a very important point in fuel oil burning, and in this blower the rotors never come in contact with each other or with the casing, which permits high rotative speed without endangering the blower, and consequently reduces the pulsations.

All the work is done by the impeller, which consists of three diamond-shaped blades and a central web, the hub of which is keyed to a steel shaft. This impeller operates in the larger portion of the casing, its blades revolving around a

cylindrical core consisting of two parts, one attached to either end plate, the web of the impeller revolving between them. This forms three pockets in which the air is taken from the inlet and forced over the outlet. Into the end plates are cast leakage pockets, which catch all the air leaking through the clearance spaces, and this air is again caught and carried forward by the following blade. This causes gradual compression, which in turn reduces the pulsations.

The idler does no work. It is located in the smaller part of the casing and consists of a symmetrical casting of three hollow vanes, or blades, whose periphery forms nearly a complete circle. The office of this rotor, revolving at the same speed as the impeller, is to form successively longitudinal spaces, or chambers of the proper size, to permit the impeller



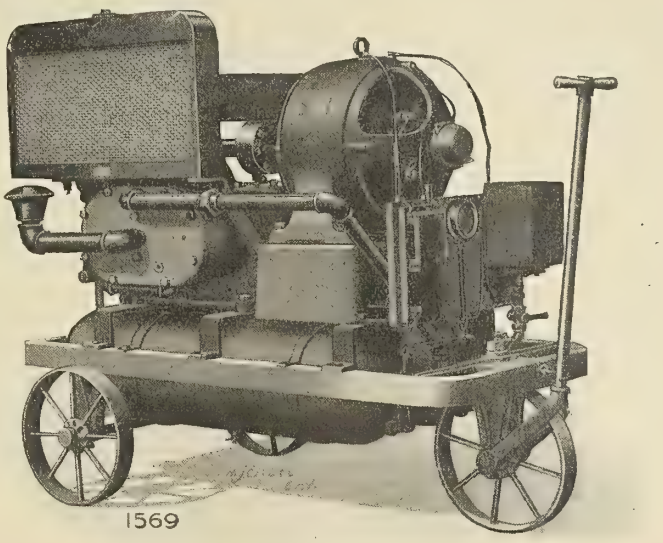
blades to return to the suction side of the blower without allowing the escape of the compresed air. As no work is done by the idler, the only power necessary to be transmitted by the gears is that required to move the idler at the proper speed.

Special care has been given to the design and construction of the bearings, which in the larger sizes are of the wedge block type, easily and accurately adjustable by the simple turning of a set screw. Peek holes are provided, which make adjustment possible without removing the end plates; in fact, many adjustments may be made while the machine is in operation. Oil is supplied by means of chain and ring oilers.

A Portable Air Compressor.

In ship yards, as in other industries, the use of pneumatic tools has proven a prime factor in economically performing certain divisions of the work, such as drilling and riveting, and has indicated the necessity for air-compressing outfits of thorough efficiency and rugged construction. The air compressor herewith illustrated is a National Type "E-1" portable outfit, manufactured by the National Brake & Electric Company, Milwaukee, Wis. This type of compressor is well adapted for service in ship yards and for outside work, where the available space is limited or the nature of the work requires that a supply of compressed air be delivered in different places and under constantly changing conditions. Its installation affords extreme flexibility, as the outfit can be easily hauled from place to place and operated at whatever point it is desired to apply the power. No extensive piping is required, and it is claimed that the cost of maintaining the system is surprisingly low.

The outfit consists of a motor compressor, reservoir and accessories, mounted on a specially built steel truck, with steel wheels and axles. Surmounting the outfit is a galvanized iron pan that provides a suitable receptacle for a length of hose which serves to conduct the compressed air from the reservoir to the place of delivery. Type "E-1" portable outfit, with



a capacity of 50 cubic feet of free air per minute, is equipped with a direct-current motor of standard design and has water-jacketed cylinder and valve heads to adapt it to continuous service. The outfit is also equipped with a radiator type of cooler, thereby providing for a free circulation of water around the cylinders and valve heads, keeping these parts at a minimum temperature.

In order to maintain the air pressure automatically within certain limits, the compressor is provided with an automatic controlling device, by means of which the compressor is started and stopped when the air supply has reached a fixed minimum or maximum pressure. The outfit complete, piped and wired, ready for instant service, includes a motor compressor, steel truck, suction strainer, automatic governor, mica insulator for motor compressor, mica insulator for automatic governor, air receiver, drain and stop cocks, pop safety valves, single-hand gage, single-throw, double-pole knife switch and fuse, hose pan and flexible hose connections, with a pair of couplings.

TECHNICAL PUBLICATIONS.

The Mechanical Engineers' Pocketbook. Eighth edition. By William Kent, M. E., Sc. D. Size, 4½ by 6¾ inches. Pages, 1,461. Illustrations, 218. New York, 1910: John Wiley & Sons. Price, $5 net.

Kent's *Mechanical Engineers' Pocketbook* is too well known to need any introduction to the engineering fraternity. The present edition is of exceptional importance, however, because the entire book has been rewritten, a task which has occupied the author four years. Some 350 pages have been added to the previous edition, and the text has been brought up to date and revised. Notwithstanding the large amount of new material which has been added the book has been brought within the limits of a comparatively small volume through the condensation and elision of much of the old matter and by resetting the tables in more condensed form. A new style of type has been adopted for tabulated matter, which is much more easily read than the old type.

It is hardly possible to more than mention some of the

important changes which have been made in the book, since to examine critically the whole volume would require more space than is available within the limits of this brief review.

The section relating to marine engineering has been changed very little. The figures which appeared in the older editions covering the design and performance of marine engines have been eliminated, since all of the data referred to reciprocating engines. In place of this figures covering the dimensions and performances of notable Atlantic steamers have been included; figures for practice, including the performance of both the boilers, engines and auxiliaries of ships typical of different decades in shipbuilding, have been introduced; also some data regarding the performance of the new Cunarder *Lusitania*. In the section devoted to the screw propeller, Barnaby's method for determining the best dimensions for screws of any speed and horsepower is explained, and an abridged table of data for use in connection with this method has been added.

Considerable change has been made in the section devoted to electricity. Instead of including data which would be useful solely for the electrical engineer it has been the aim of the author to make the section on electricity include only such information as a mechanical engineer should possess in order to handle electrical machinery.

The sections relating to materials, strength of materials and iron and steel have necessarily been considerably changed to conform with the latest engineering practice. Many new tables have been incorporated in these sections, and some of the older tables relating to the strength of materials have been considerably enlarged. In the section on iron and steel the most recent specifications for various grades of iron and steel are included and the new alloy steels are thoroughly discussed.

A large part of the book is devoted to power and its various applications. A new steam table, based on the work of Marks and Davis, has been calculated, dealing with both saturated and superheated steam. New sections covering steam turbines and gas engines are included; smoke prevention is given considerable attention; the problems relating to air, fans, blowers, etc., are made very complete.

The foregoing is but an indication of the many important features of the book, but engineers who are familiar with the earlier editions will realize the value and importance of this new edition.

Engineering of To-day. By Thomas W. Corbin. Size, 5 by 7½ inches. Pages, 367. London, 1910: Seeley & Company, Ltd., 38 Great Russell street. Price, 5s.

This is the sixth volume of a capital series on "Science of To-day." The previous issues met with the highest approval, and the present book, the sub-title of which is "A Popular Account of the Present State of the Science, with Many Interesting Examples Described in Non-Technical Language," is likely to receive a meed of praise equal to that accorded to the previous five volumes. Mr. Corbin is well qualified to deal with the subject of engineering in an authoritative way, and one is attracted by his lucid and interesting style, which is made still more attractive by the accompaniment of some forty illustrations and diagrams.

The introductory chapters deal with "power," and the author writes in a simple yet attractive way on the steam engine, gas engine, running water and power transmission. Then follow sections on various engineering topics and work, and among these a fair amount of space is devoted to marine matters. A preliminary chapter on "Iron and Steel Ships" is followed by two chapters on "The Building of Ships" and "Curious Ships." In the pages on building the author includes an account of the launch of the battleship *Neptune*. The "Curious Ships" described are repair vessels, self-discharging colliers, dredgers and cable-repairing ships. War vessels have a special chapter of fourteen pages, and various types are mentioned. The marine section of the book is concluded by a chapter on "Submarine Diving."

Among other topics touched upon are electric traction, railways, gas manufacture, water supply, lifting and conveying machinery, protection from fire. As indicated above, these subjects are not dealt with for the professional reader, as technical terms are avoided; it is a purely popular exposition of what engineering is in daily life, and as such it is superior to a good many popular treatises which we can recall.

Submarines for the World's Navies. By Charles W. Domville-Fife. Size, 7½ by 10 inches. Pages, 160; illustrations, 61. London, 1910: Francis Griffiths. Price, 21s. net.

The author has gone to a good deal of trouble in collecting as much information as possible concerning the submarine branch of the navies of the world; but we imagine that he has been handicapped in his efforts, both as far as information and illustrations are concerned, owing to the reticence of the several governments with which he has dealt. The first section of the book shows at considerable length how the coast lines of the different countries are defended by submarine torpedo boats, and the boats of Great Britain, France, Russia, United States, Italy, Japan, Germany, Sweden and Spain are considered. Some interesting reference tables are added to this section, with notes on trials containing a description of every naval submarine afloat or in the course of construction. The second part deals with submarine warfare, and this has been added, says the author, to show the tactical value of the daylight torpedo boats. Submarine construction is dealt with in this section, and some interesting skeleton plans are included, showing actual types of vessels. Several papers by well-known writers are given in the last section. These include "Submarines in Open Warfare" (Sir J. O. Hopkins); "Submarines vs. Torpedo Boats" (Sir Cyprian Bridge); "Submarines in Future Naval Warfare" (the late constructor of the French navy); "Submarines" (Lieut. Sir A. Trevor Dawson); "The Arm of the Submarine" (Capt. Edgar Eees); "The Dangers of the Submarine, Real and Imaginary" (Lawrence T. Spear, U. S. N.). Some of these will be recognized as reprinted articles. The book is well printed, and some of the illustrations are excellent, adding value to the book.

Hendricks' Commercial Register of the United States (Buyers and Sellers). Size, 7½ by 10 inches. Pages, 1,342. New York, 1910: Samuel E. Hendricks Company. Price, $10.

The 19th annual Revised Edition of Hendricks' Commercial Register of the United States for Buyers and Sellers has just been issued. It is by far the most complete edition of this work so far published. The 18th edition required 87 pages to index its contents, while the 19th edition requires just 100 pages, or 13 additional pages. As there are upwards of 400 classifications on each page, the 13 additional pages represent the manufacturers of over 5,000 articles, none of which have appeared in any previous edition. The total number of classifications in the book is 35,481, each representing some machine tool specialty or material required in the architectural, engineering, mechanical, electrical, railroad, mine and kindred industries. The 18th edition numbered 12,220 pages, while the 19th edition numbers 1,344, or 124 additional pages. One hundred and fourteen pages of matter have been omitted from the new edition that appeared in the 18th edition. This makes a total of 238 pages of new matter, the whole representing upwards of 350,000 names and addresses. An important feature of the Register is the simplicity of its classifications. They are so arranged that the book can be used for either purchasing or mailing purposes. The value of the book for purchasing purposes is not confined to its complete classifications alone; it also gives much information following

the names of thousands of firms that is of great assistance to the buyer, and saves the expense of writing to a number of firms for the particular article required. The trade names of all articles classified in the book are also included as far as they can be secured.

The Romance of the Ship. By E. Keble Chatterton. Size, 5 by 7½ inches. Pages, 314. London, 1910: Seeley & Company, Ltd., 38 Great Russell street. Price, 5s.

One is immediately drawn to the very attractive cover which encases this well-written popular exposition. Mr. Chatterton has, during the past few months, been responsible for no less than four fairly good-sized works, and the present volume is a natural outcome of his two previous studies on "Sailing Ships" and "Steam Ships." In the preparation of these two interesting historical books, which have met with much approval, Mr. Chatterton has gathered enough material for his new work, which is a worthy addition to the "Library of Romance." The author has apparently felt the limitations of trying to compact into a single volume all he might say on the evolution of shipbuilding, and he has aimed at giving a picture of the gradual growth of marine propulsion in an attractive and interesting style. He has endeavored to interest his non-technical readers in a subject upon which it is apparent he is most enthusiastic, and his enthusiasm is certainly contagious. Some thirty-four excellent illustrations are included.

COMMUNICATION.

Comment on the Boat Problem.

Editor International Marine Engineering:

We have read your article, "The Boat Problem," by Mr. Walker, with much interest. The only point we should wish to alter his opinion upon is where he states that steel boats will not stand knocking about when lying alongside accommodation ladders the same as a wooden boat will. With a decent rubber our steel boats are quite equal to wooden boats in that respect, and if there is any amount of sea on they are infinitely better. We have had cases where the wooden boats have been stoved in under such circumstances where you could not find any marks on our boats.

Wakefield. The Seamless Steel Boat Company, Ltd.

PERSONAL.

Professor Walter S. Leland, of the department of naval architecture and marine engineering of the Massachusetts Institute of Technology, has tendered his resignation, to take effect at the end of the present term. Professor Leland has been at the Institute for ten and a half years, during five and a half of which he has been a member of the faculty. Soon after the first of the year he will become associated with the San Francisco Bridge Company of San Francisco, Cal., who are affiliated with the Atlantic, Gulf & Pacific Company of New York.

John Haug, consulting engineer and naval architect, has opened an office at 24 California street, San Francisco, Cal. For the last five years Mr. Haug has been engineer-in-chief of the marine department of the Standard Oil Company of California. Previous to that he has spent many years in marine work in Germany, England and the United States, being for twenty years ship and engineer surveyor for Lloyd's Register at Philadelphia.

Duncan Gray Macfarlane, for many years a chief engineer aboard steamships of the Cunard Line, has just retired, having reached the age limit for service. For the last five years Mr. Macfarlane has served as chief engineer of the *Caronia*. When Mr. Macfarlane first joined the Cunard Line in 1872, he was assigned to the *Scotia*, a side-wheel steamship, and was with her during the last five years of her existence as a North Atlantic passenger steamship.

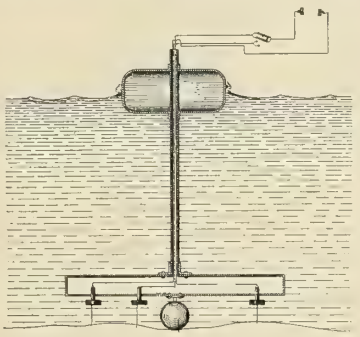
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

964,380. APPARATUS FOR SUBMARINE SIGNALING. THOMAS JAMES BOWLKER, OF BOSTON, MASS.

Claim 1.—The combination of a pair of transmitters submerged in water and sensitive to sound waves passing through said water, a pair of receivers connected with said transmitters and adapted to be applied to the ears of an operator, and connections from said transmitters to



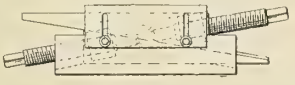
said receivers, said transmitters being spaced apart by a distance representing the proximate distance apart of said receivers multiplied by the ratio of velocity of sound in water as compared with the velocty of sound in air. Seven claims.

967,741. COMBINATION DREDGE AND CONVEYER. FRANKLIN P. EASTMAN, OF NEW YORK, N. Y.

Claim 1.—A combination dredge and conveyer, comprising a bucket mounted to swing and to travel bodily to and from the material to be removed, means for drawing the bucket forward and backward, the bucket on its forward movement passing into the material at the time the mouth of the bucket is in an approximately vertical position, and means for returning the bucket to normal upright position. Five claims.

965,302. KEEL-BLOCK. PHILIP KEYMER, OF CLEVELAND, OHIO.

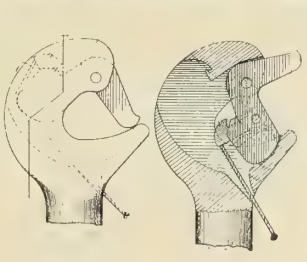
Claim 2.—A keel block comprising a pair of wedge members, a screw rod having right and left hand threads thereon, nuts on said threads, one of said nuts connected to a lower wedge member, another of said nuts



connected with an upper wedge member, the connections of said nuts and wedge members permitting a change in the inclination of said screw rod. Eight claims.

965,655. BOAT-RELEASING HOOK. JOSEPH YATES PORTER, JR., OF KNIGHTS KEY, FLA.

Claim 2.—A boat-releasing hook comprising a rigid hook body having a lateral oepning; a finger pivotally mounted in said body to close said opening; a tail piece rigidly connected with said finger; a movable latch member pivotally mounted in said tail piece to engage said hook body



when said finger is in position to close said opening; a flexible transmission member connected to said latch and to an operating station removed from said hook; and a projection mounted on said tail piece and extended to support and guide said flexible member within said hook body. Three claims.

966,654. SCREW-PROPELLER. CLEMENT COMA, OF PARIS, FRANCE.

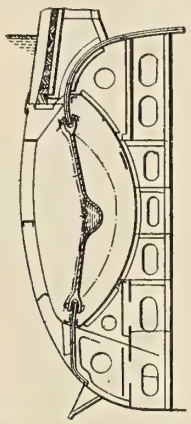
Claim.—In a screw propeller for ships and such like, the combination with a shaft, of a plurality of propellers mounted on said shaft, said propellers comprising a hub and a plurality of blades, a truncated member secured to said shaft, a plurality of helical propeller blades fastened to said member, the width of said helical blades increasing toward the larger end of said member. One claim.

970,368. MEANS FOR DAMPING THE ROLLING MOTION OF SHIPS. HERMAN FRAHM, OF HAMBURG, GERMANY.

Claim 6.—In ships, means for damping rolling, comprising water vessels widening toward their upper ends, a cross connection joining the lower ends of said vessels, a cross pipe joining the upper closed ends of said vessels, and means for throttling the passage of air through said last-mentioned cross pipe. Twenty-three claims.

966,813. SHIP OR VESSEL. GIOVANNI EMANUELE ELIA, OF PARIS, FRANCE.

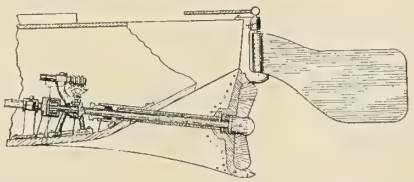
Claim 1.—A device for protecting ships from the effects of submarine explosions, comprising a chamber extending around the portion of the ship to be protected, a plurality of strong cables aranged within the said



chamber, and rows of weaker cables connected to the aforesaid cables in such manner as to retain the latter in a partly contracted condition. Thirteen claims.

965,870. PROPELLER AND BOAT CONSTRUCTION. WILLIAM L. CASADAY, OF SOUTH BEND, IND.

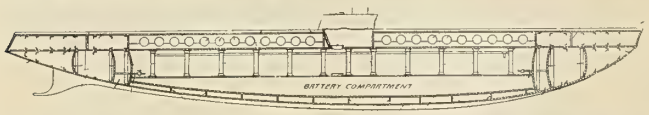
Claim 1.—Propelling mechanisms for boats embracing a propeller, a stern post adapted to be secured to the boat and shaped to fit to the inner edges of the buckets of the propeller as the same revolves and to



afford continuous cutting edge for the entire length thereof in conjunction with the edges of the buckets and a downward and rearward extension secured to said stern post extending beneath the propeller and rearwardly therefrom. Nineteen claims.

970,064. SUBMARINE BOAT. SIMON LAKE, OF MILFORD, CONN.

Claim 6.—A submarine boat, comprising an inner hull section, and an outer hull section of the same length, constructed to resist external pressure when the boat is submerged, bow and stern portions extending from the hull sections, a storage battery compartment arranged centrally

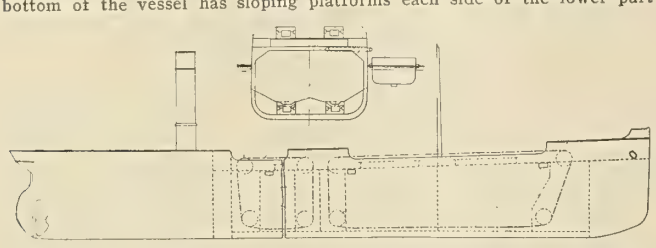


in the space formed between the hull sections, ballast tanks formed in the said space, means for admitting water to the said tanks, means for emptying said tanks, a superstructure of light weight construction arranged over the hull sections and means for admitting water into the superstructure space. Seventeen claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

11,970. VESSELS FOR CARRYING BULK CARGO. P. B. CLARKE, LIVERPOOL.

The vessel is fitted with conveyors which extend along the bottom of the holds, up and down at each end, and over the hatches. The lower run passes over wheels, and the upper run over similar wheels. The bottom of the vessel has sloping platforms each side of the lower part



of the conveyors, on which the cargo rests, and they feed it to the conveyor, which is supported on rollers and runs between rails. Laterally disposed conveyors are arranged in connection to convey the material supplied, by conveyors, overboard.

1433. COMBINED AHEAD AND ASTERN TURBINES. BROWN BOVERI ET CIE., BADEN, SWITZERLAND.

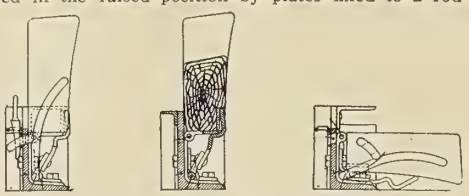
By this invention, ahead and astern turbines are placed within a common casing, with their exhaust ends adjacent and separated by a partition, which is provided with a packing at the part where the shaft passes through, and there are chambers within the packing connected so that any steam leaking through a part of the packing is conducted to the low-pressure stage of another turbine, to the condenser or to the atmosphere.

15,977. POWER-DRIVEN BOATS. SIR J. I. THORNYCROFT AND T. THORNYCROFT, CHISWICK.

This boat has its bow portion more or less of the ordinary contour, this contour extending rearward to about the center, where the under side of the boat suddenly turns upwards and then backwards, merging into a flat horizontal stern portion, below which the propeller and its shaft extends. When the boat is at rest or traveling at a moderate speed the forward portion is well immersed and the rearward portion is immersed less and less from the upwardly extending shoulder. Upon the boat being driven at a greater speed, the forward portion rises until at or above a predetermined speed the boat is supported only by the lower portion adjacent to and forward of the shoulder, and by the more or less flat rearward portion, an air space being left below the upwardly and backwardly curved middle portion between these parts.

18,851. BOAT DISENGAGING AND SUPPORTING GEAR. W. JAMES, SOUTH SHIELDS.

Relates to chocks; these are hinged at their lower parts so that when unsupported they fall over by gravity and leave the boat clear. They are supported in the raised position by plates fixed to a rod provided



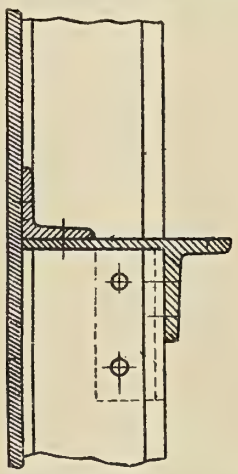
with a hand lever by which the rod can be turned so as to raise the supporting plates, and thereby the chocks. For securing the chocks in the raised position a pin is thrust into a slot of the lever.

19,754. BRAKES FOR SHIPS' RUDDERS. C. A. JACKSON, EAST BOLDON, DURHAM.

This invention relates to means for preventing shock to the gear when a sea strikes the rudder. It comprises a cylinder filled with liquid and furnished with a piston having a piston rod extending through each end of the cylinder, the ends of the cylinder being connected by a valve-controlled passage. When the rudder is moved over to either side the cylinder is moved relatively to the piston, or *vice versa*, and the flow of liquid displaced from one side of the piston to the other is impeded more or less.

27,146. IRON SECTION FOR SHIP BUILDING. W. OVERHOFF, SAN ROCCO, NEAR TRIEST.

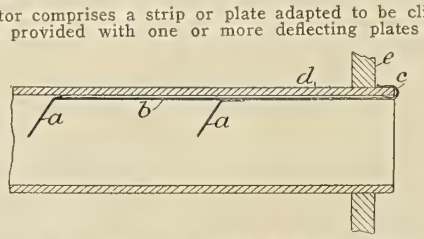
This section is characterized by a cross flange arranged at one side of the web, which is wider and thinner than the web, and the other cross



flange; further a sharp right angle is formed between the web and wider cross flange.

22,120. MEANS FOR DEFLECTING THE DRAUGHT IN THE TUBES OF MARINE AND OTHER BOILERS. T. M. BROOM, GREENOCK.

This deflector comprises a strip or plate adapted to be clipped to the tube-end and provided with one or more deflecting plates of substan-



tially semi-circular form. One end of the strip is provided with a hook-shaped clamping spring for attachment to the tube.

16,553. DISCHARGE OF ASHES BELOW THE WATER LINE. F. J. WHITE, WOODFORD.

This is an apparatus of the kind comprising a continuously or intermittently driven chambered cock, or valvular device, and the invention consists in the combination with a lubricator for the valvular device, the lubricator being of the kind comprising a lubricant ejecting piston having a step by step feed, and a variable crank for driving it and enabling the working to be suited to various conditions.